*Supporting information*

# $CBr_4$ - Mediated Cross-Coupling Reactions of *a*-Aminocarbonyl Compounds with Alcohols and Thiols to Build C-O Bond and C-S Bond

Xingxing Liu, [a] Jinghong Pu, [a] Xinliang Luo, [a] Xinfeng Cui, [a] Zhaoyang Wu, [b] Guosheng Huang [a]*

[a] State Key Laboratory of Applied Organic Chemistry, Key Laboratory of Nonferrous Metal Chemistry and Resources Utilization of Gansu Province, Department of Chemistry, Lanzhou University, Lanzhou 730000, China.

[b] The Environmental Protection Agency of Rudong Coastal Economic Development Zone, Nantong 226400, China

E-mail: hgs@lzu.edu.cn Fax: +86 931891258

## Table of Contents

## *1.* General information

All of the reactions were carried out in oven-dried flask. Products were purified by flash chromatography on 200–300 mesh silica gels. Analytical TLC was performed with Merck silica gel 60 F254 plates, and the products were visualized by UV detection. Unless otherwise noted, chemical shifts (δ) are reported in ppm using TMS as internal standard; $^{1}$H NMR (400 MHz) and $^{13}$C NMR (100 MHz) spectras were recorded in $CDCl_3$ (δ = 77.00 ppm). The high resolution mass spectra (HRMS) were recorded on an FT-ICR mass spectrometer using electrospray ionization (ESI). Melting points were determined on a microscopic apparatus. 76 and $^{13}$C NMR spectra are provided. Commercially available reagents were used without further purification.

## *2.* Typical Experimental Procedure

### *(A ) Synthesis of starting materials*

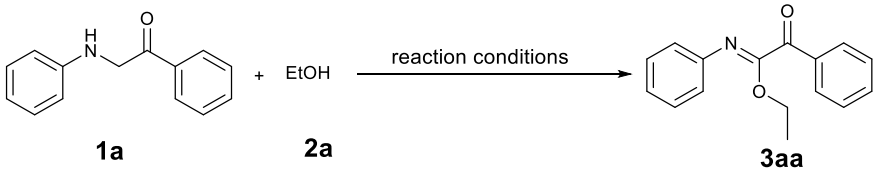
Substrates **1** were prepared according to the known procedures. [1,2]

### *(B) Screening for optimal reaction conditions of ethanol with a-aminocarbonyl.*

To begin our work, 1-phenyl-2-(phenylamino)ethan-1-one **1a** (0.2 mmol) and ethanol **2a** (2 mL) were employed as model reactants. As shown in Table *S1*, only a trace amount of product ethyl -2-oxo-*N*,2-diphenylacetimidate **3aa** was observed in the presence of $CBr_4$ (1.5 equiv.) under air at room temperature (Table *S1*, entry 1). However, when the reaction was carried out in basic conditions, the yield of product was improved observably. Further investigation of the effect of the bases revealed that the yield of **3aa** was greatly increased to 62% with NaOH (4.0 equiv.) (Table *S1*, ertries 2-7). Meanwhile, both increasing and decreasing the loading of NaOH resulting in lower yields (Table *S1*, entries 8-9). Subsequently, changing the amount of $CBr_4$ to 2.0 equivalent, the desired product **3aa** was given in 87% yield (Table 1, entries 10 - 12). After a battery of trials, we found that using mixture solvent by adding some other solvents such as DCM, MeCN and DMSO did not make any improvement and the absolute ethanol was more suitable (Table *S1*, entries 13-15). Besides, a series of halogenated reagents, including NBS, $CCl_4$, TBAB, $CBrCl_3$ were examined; the results proved that $CBr_4$ was the most effective (Table *S1*,

entries 16- 19). In addition, in the absence of $CBr_4$, the reaction could not proceed (Table *S1*, entry 20). Moreover, when we conducted the reaction under oxygen atmosphere or nitrogen atmosphere, the yield of **3aa** did not increase, giving the C – O bond formation product in 64% and 40% yield, respectively (Table *S1*, entries 21 - 22). After exploring different parameters, the highest yield of **3aa** was achieved when the reaction was carried out with $CBr_4$ (2.0 equiv.) and NaOH (4.0 equiv.) in ethanol (2 mL) under air at room temperature ( Table *S1*, entry 11).

***Table S1. Screening for optimal reaction conditions.*** [a]




**1a** **2a** **3aa**

| Entry | Hal./equiv. | Base/equiv. | Additive Solvent | Yield (%) [b] |
|---|---|---|---|---|
| 1 | $CBr_4$ (1.5) | -- | | trace |
| 2 | $CBr_4$ (2.0) | $Et_3N$ (4.0) | - | 38 |
| 3 | $CBr_4$ (2.0) | DBU (4.0) | - | 41 |
| 4 | $CBr_4$ (2.0) | DABCO (4.0) | - | 25 |
| 5 | $CBr_4$ (2.0) | KOH (4.0) | - | 42 |
| 6 | $CBr_4$ (2.0) | *t*-BuOK | - | 33 |
| 7 | $CBr_4$ (1.5) | NaOH (4.0) | - | 62 |
| 8 | $CBr_4$ (1.5) | NaOH (3.0) | - | 46 |
| 9 | $CBr_4$ (1.5) | NaOH (5.0) | - | 60 |
| 10 | $CBr_4$ (1.0) | NaOH (4.0) | - | 56 |
| **11** | **$CBr_4$ (2.0)** | **NaOH (4.0)** | **-** | **87** |
| 12 | $CBr_4$ (2.5) | NaOH (4.0) | - | 74 |
| 13[c] | $CBr_4$ (2.0) | NaOH (4.0) | DCM | 72 |
| 14[c] | $CBr_4$ (2.0) | NaOH (4.0) | MeCN | 68 |
| 15[c] | $CBr_4$ (2.0) | NaOH (4.0) | DMSO | 44 |
| 16 | NBS (2.0) | NaOH (4.0) | - | 28 |
| 17 | $CCl_4$ (2.0) | NaOH (4.0) | - | 0 |
| 18 | TBAB (2.0) | NaOH (4.0) | - | 0 |
| 19 | $CBrCl_3$ | NaOH (4.0) | - | 42 |
| 20 | -- | NaOH (4.0) | -- | 0 |
| 21[d] | $CBr_4$ (2.0) | NaOH (4.0) | - | 64 |
| 22[e] | $CBr_4$ (2.0) | NaOH (4.0) | - | 76 |

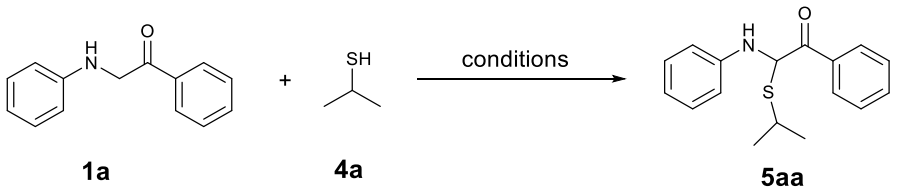
[a] Reaction conditions: **1a** (0.2 mmol), **2a** (2 mL), base and solvent (1 mL) under air atomsphere at room temperature for 4 h. [b] Yield of isolated product. [c] EtOH (1 mL). [d] Under $O_2$ (1 atm) atmosphere. [e] Under $N_2$ (1 atm) atmosphere. $Et_3N$ = Triethylamine. DBU = 1,8-Diazabicyclo[5.4.0]undec-7-ene. DABCO = Triethylenediamine. DCM = Dichloromethane. DMSO = Dimethyl sulfoxide. NBS = N-Bromosuccinimide. TBAB = Tetrabutylammonium bromide.

***(C) Screening for optimal reaction conditions of thiol with a-aminocarbonyl.***

Initially, we carried out the reaction of 1-phenyl-2-(phenylamino)ethan-1-one **1a** (0.2 mmol) with propane-2-thiol (2 mL) using $CBr_4$ (2.0 equiv.) and NaOH (4.0 equiv.) under

air at room temperature, the product 2-(isopropylthio)-1-phenyl-2-(phenylamino)ethan-1-one **5aa** was successfully obtained in 42% yield (Table *S2*, entry 1). Encouraged by this result, we continued optimizing the other reaction parameters. Firstly, we screened different bases, the results indicated that DABCO was superior than the other bases tested such as $Et_3N$, DBU, DMAP, giving the desired product **5aa** in 68% (Table *S2*, entries 2 -6). In the absence of base, 5aa was detected in 28% (Table *S2*, entry 7). Futhermore, changing the loading of DABCO found that 4.0 equivalent was the best choice (*Table S2*, entries 4, 8-9). Moreover, no matter increasing the amount of $CBr_4$ or decreasing it, the yields of product did not get any improvement (*Table S2*, entries 4, 10-11). Subsequently, the effect of different solvents was surveyed. Among the solvents tested, MeCN proved to the most effective comparing to DCE, DMSO and DMF, affording the desired product **5aa** in 91% yield (Table *S2*, entries 12-15). After a series of trials, we found that other halogenated regents such as NBS, CCl4, TBAB and CBrCl3 did not provide any better results (*Table S2*, entries 16 - 19). Notably, the reaction could not proceed soomthly in the absence of $CBr_4$ (*Table S2*, entry 20). In addition, the reaction could be conducted smoothly under $O_2$ or $N_2$ atmosphere, giving the product 2-(isopropylthio)-1-phenyl-2-(phenylamino)ethan-1-one **5aa** in 81% and 72%, respectively (Table *S2*, entries 21 and 22). All together it was discovered that 2.0 equivalent of $CBr_4$ with 4.0 equivalent of DABCO in $CH_3CN$ at room temperature under air were the optimized reaction conditions (Table *S2*, entry13).

***Table S2***: Screening for optimal reaction conditions [a]



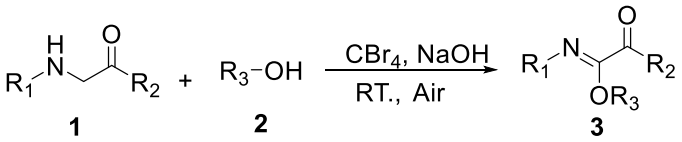

**1a** **4a** **5aa**

| Entry | Hal./ equiv. | Base/ equiv. | Additive Solvent | Yield(%)[b] |
|---|---|---|---|---|
| 1 | $CBr_4$ (2.0) | NaOH (4.0) | -- | 42 |
| 2 | $CBr_4$ (2.0) | $Et_3N$ (4.0) | -- | 28 |
| 3 | $CBr_4$ (2.0) | DBU (4.0) | -- | 20 |
| 4 | $CBr_4$ (2.0) | DABCO (4.0) | | 68 |
| 5 | $CBr_4$ (2.0) | DMAP (4.0) | | 53 |

| | | | | |
|---|---|---|---|---|
| 6 | $CBr_4$ (2.0) | TMEDA (4.0) | | 42 |
| 7 | $CBr_4$ (2.0) | -- | -- | 28 |
| 8 | $CBr_4$ (2.0) | DABCO (3.0) | -- | 60 |
| 9 | $CBr_4$ (2.0) | DABCO (5.0) | -- | 47 |
| 10 | $CBr_4$ (1.5) | DABCO (4.0) | -- | 61 |
| 11 | $CBr_4$ (2.5) | DABCO (4.0) | -- | 56 |
| 12[c] | $CBr_4$ (2.0) | DABCO (4.0) | DCE | 58 |
| **13**[c] | **$CBr_4$ (2.0)** | **DABCO (4.0)** | **MeCN** | **91** |
| 14[c] | $CBr_4$ (2.0) | DABCO (4.0) | DMSO | 44 |
| 15[c] | $CBr_4$ (2.0) | DABCO (4.0) | DMF | 72 |
| 16[c] | NBS | DABCO (4.0) | MeCN | 21 |
| 17[c] | $CCl_4$ | DABCO (4.0) | MeCN | 38 |
| 18[c] | TBAB | DABCO (4.0) | MeCN | 26 |
| 19[c] | $CBrCl_3$ | DABCO (4.0) | MeCN | 48 |
| 20[c] | -- | DABCO (4.0) | MeCN | trace |
| 21[c,d] | $CBr_4$ (2.0) | DABCO (4.0) | MeCN | 81 |
| 22[c,e] | $CBr_4$ (2.0) | DABCO (4.0) | MeCN | 72 |

[a] Reaction conditions: **1a** (0.2 mmol), **4a** (2 mL), base and solvent (1 mL) under air atomsphere at room temperature for 15 h. [b] Yield of isolated product. [c] **4a** (1mL). [d] Under $O_2$ (1 atm) atmosphere. [e] Under $N_2$ (1 atm) atmosphere. $Et_3N$ = Triethylamine. DBU = 1,8-Diazabicyclo[5.4.0]undec-7-ene. DABCO = Triethylenediamine. DMAP = dimethylaminopyridine. TMEDA = Tetramethylethylenediamine. DCE = Dichloroethane. DMSO = Dimethyl sulfoxide. DMF = Dimethyl formamide. NBS = *N*-Bromosuccinimide. TBAB = Tetrabutylammonium bromide.

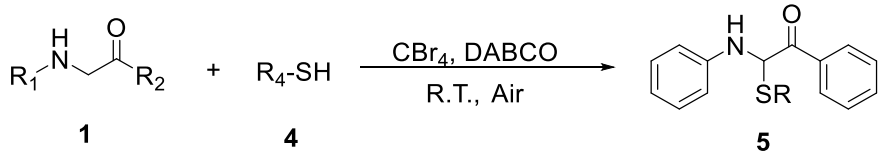
***(D) Typical Experimental Procedure for the $CBr_4$-Mediated C-O Bond Formation Products (3):***




**1** **2** **3**

An oven-dried tube with a magnetic stir bar was charged with the α-amino carbonyl compound **1** (0.2 mmol), $CBr_4$ (2.0 equiv) and NaOH (4.0 equiv) in alcohol **2** (2.0 mL). If the alcohol is the solid, DCM (1 mL) and alcohol (4.0 equiv.) would be added. Then the reaction mixture was stirred at room temperature under air until complete consumption of starting material as monitored by TLC. After the reaction was finished, the mixture was concentrated in vacuum, and the residues were purified by silica gel column chromatography (hexane/ethyl acetate = 40:1) to afford the desired product **3**.

***(E) Typical Experimental Procedure for the $CBr_4$-Mediated C-S Bond Formation Products (5):***




**1** **4** **5**

An oven-dried tube with a magnetic stir bar was charged with the α-amino carbonyl compound **1** (0.2 mmol), $CBr_4$ (2.0 equiv) and DABCO (4.0 equiv) in the mixture of thiol **4** (1.0 mL) and MeCN (1.0 mL). If the thiol is the solid, thiol (4.0 equiv.) would be added. Then the reaction mixture was stirred at room temperature under air until complete consumption of starting material as monitored by TLC. After the reaction was finished, the mixture would be extracted with EtOAc, washed with brine, dried over $Na_2SO_4$, and then evaporated. The residues were purified by silica gel column chromatography (hexane/ethyl acetate = 40:1) to afford the desired product **5**.

## *3.* References

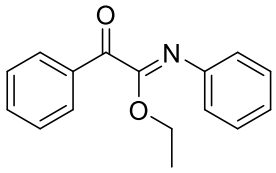

[1] F. Lakner, M. Parker, B. Rogovoy, A. Khvat and A. Ivachtchenko, *Synthesis,* **2009**, *12*, 1987.

[2] M. Pal, N. Swamy, P. Hameed, S. Padakanti and K. Yeleswarapu, *Tetrahedron*, **2004**, *60*, 3987.

[3] P. K. Prasad, R. N. Reddi and Arumugam Sudalai, *Org. Lett.*, **2016**, *18*, 500.

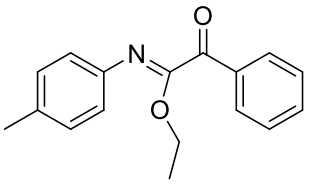
[4] X.D. Li, M. Chen, X. Xie, N. Sun, S. Li and Y.H. Liu, *Org. Lett.*, **2015**, *17*, 2984.


## *4.* Characterization and analytical data of products



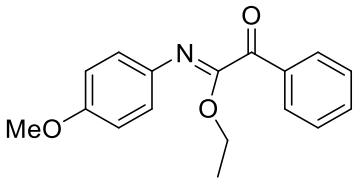

**Ethyl-2-oxo-*N*,2-diphenylacetimidate (3aa)**

Yellow oil (m = 44mg, 88%); $^1$**H NMR** (400 MHz, $CDCl_3$) δ: 7.82 (d, *J* = 7.5 Hz, 2H), 7.58 – 7.54 (m, 1H), 7.43 (t, *J* = 7.7 Hz, 2H), 7.12 (t, *J* = 7.8 Hz, 2H), 6.93 (t, *J* = 7.4 Hz, 1H), 6.84 (d, *J* = 7.6 Hz, 2H), 4.51 (q, *J* = 7.1 Hz, 2H), 1.46 (t, *J* = 7.1 Hz, 3H); $^{13}$**C NMR** (101 MHz, $CDCl_3$) δ: 190.03, 156.87, 145.43, 134.41, 133.61, 129.50, 128.72, 123.81, 121.50, 63.01, 14.14. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{16}H_{15}NO_2H^+$ 254.1176, found 254.1179.



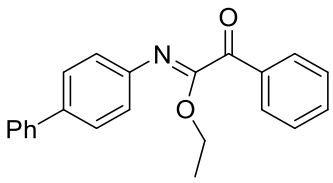
**Ethyl-2-oxo-2-phenyl-*N*-(*p*-tolyl)acetimidate (3ba)**

Yellow oil (m = 49mg, 92%); **$^{1}$H NMR** (400 MHz, $CDCl_3$) δ: 7.82 (d, *J* = 7.5 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.43 (t, *J* = 7.7 Hz, 2H), 6.92 (d, *J* = 8.0 Hz, 2H), 6.73 (d, *J* = 8.0 Hz, 2H), 4.50 (q, *J* = 7.1 Hz, 2H), 2.19 (s, 3H), 1.45 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) δ: 190. 30, 156.77, 142.81, 134.35, 133.72, 133.21, 129.55, 129.36, 128.73, 121.35, 62.90, 20.70, 14.17. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{17}NO_2H^+$ 268.1332, found 268.1336.



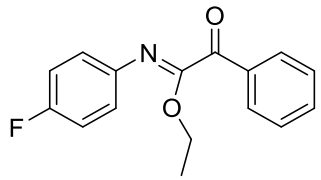
**Ethyl-*N*-(4-methoxyphenyl)-2-oxo-2-phenylacetimidate (3ca)**

Yellow oil (m = 42mg, 74%); **$^{1}$H NMR** (400 MHz, $CDCl_3$) δ: 7.82- 7.79 (m, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.42 (t, *J* = 7.7 Hz, 2H), 6.78 (d, *J* = 8.8 Hz, 2H), 6.66 (d, *J* = 8.8 Hz, 2H), 4.49 (q, *J* = 7.1 Hz, 2H), 3.67 (s, 3H), 1.44 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) δ: 190.65, 156.93, 156.12, 138.46, 134.41, 133.51, 129.49, 128.75, 122.51, 114.02, 62.91, 55.20, 14.15. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{17}NO_3H^+$ 284.1281, found 284.1279.



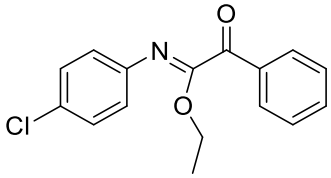
**Ethyl-*N*-([1,1'-biphenyl]-4-yl)-2-oxo-2-phenylacetimidate (3da)**

Yellow solid (m = 57 mg, 87%); m.p. : 113.4-117.0 $^{o}$C; **$^{1}$H NMR** (400 MHz, $CDCl_3$) δ: 7.82 (d, *J* = 7.5 Hz, 2H), 7.53 (t, *J* = 7.4 Hz, 1H), 7.46 – 7.39 (m, 4H), 7.36 – 7.32 (m, 4H), 7.24 (t, *J* = 7.3 Hz, 1H), 6.89 (d, *J* = 8.2 Hz, 2H), 4.51 (q, *J* = 7.1 Hz, 2H), 1.45 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) δ: 190.05, 156.92, 144.72, 140.49, 136.54, 134.49, 133.56, 129.53, 128.77, 128.57, 127.38, 126.81, 126.61, 121.89, 63.09, 14.13. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{22}H_{19}NO_2H^+$ 330.1489, found 330.1492.



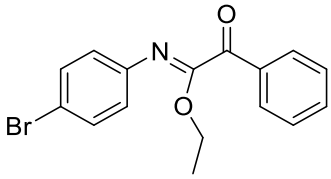
**Ethyl-*N*-(4-fluorophenyl)-2-oxo-2-phenylacetimidate (3ea)**

Yellow oil (m = 47 mg, 86%); **$^{1}$H NMR** (400 MHz, $CDCl_3$) δ: 7.85 - 7.81 (m, 2H), 7.15 – 7.07 (m, 4H), 6.94 (t, *J* = 7.4 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 2H), 4.50 (q, *J* = 7.1 Hz, 2H), 1.46 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, $CDCl_3$) δ: 188.44, 166.40 (d, *J* = 258.9 Hz), 156.59, 145.31, 132.27 (d, *J* = 9.8 Hz), 130.12, 128.79, 123.95, 121.44, 116.12 (d, *J* = 22.3 Hz), 63.13, 14.13. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{16}H_{14}FNO_2H^+$ 272.1082, found 272.1086.



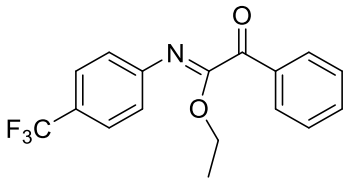
**Ehyl-*N*-(4-chlorophenyl)-2-oxo-2-phenylacetimidate (3fa)**

Yellow oil (m = 48 mg, 84%); **$^{1}$H NMR** (400 MHz, CDCl3) δ: 7.80 (d, *J* = 7.4 Hz, 2H), 7.58 (t, *J* = 7.6 Hz, 1H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.08 (d, *J* = 8.6 Hz, 2H), 6.76 (d, *J* = 8.6 Hz, 2H), 4.49 (q, *J* = 7.1 Hz, 2H), 1.45 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, CDCl3) δ: 189.64, 157.38, 144.13, 134.66, 133.44, 129.49, 129.14, 128.87, 128.80, 122.82, 63.22, 14.10. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{16}H_{14}ClNO_2H^+$ 288.0786, found 288.0784.



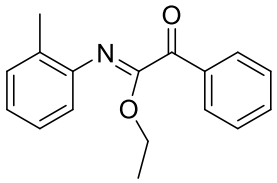
**Ethyl-*N*-(4-bromophenyl)-2-oxo-2-phenylacetimidate (3ga)**

Yellow oil (m = 50 mg, 76%); **$^{1}$H NMR** (400 MHz, CDCl3) δ: 7.79 (d, *J* = 7.5 Hz, 2H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.22 (d, *J* = 8.5 Hz, 2H), 6.70 (d, *J* = 8.4 Hz, 2H), 4.48 (q, *J* = 7.1 Hz, 2H), 1.44 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, CDCl3) δ: 189.58, 157.32, 144.64, 134.69, 133.46, 131.75, 129.51, 128.89, 123.26, 116.90, 63.25, 14.11. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{16}H_{14}BrNO_2H^+$ 332.0281, found 332.0284.



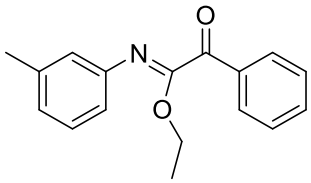
**Ethyl-2-oxo-2-phenyl-*N*-(4-(trifluoromethyl)phenyl)acetimidate (3ha)**

Yellow oil (m = 44 mg, 68%); **$^{1}$H NMR** (400 MHz, CDCl3) δ: 7.82 (d, *J* = 7.4 Hz, 2H), 7.62 – 7.58 (m, 1H), 7.46 (t, *J* = 7.7 Hz, 2H), 7.39 (d, *J* = 8.3 Hz, 2H), 6.91 (d, *J* = 8.2 Hz, 2H), 4.52 (q, *J* = 7.1 Hz, 2H), 1.47 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, CDCl3) δ: 189.05, 157.38, 148.91, 134.78, 133.49, 129.53, 128.93, 125.98 (q, J = 3.7 Hz), 122.86, 121.63, 63.43, 14.08. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{14}F_3NO_2H^+$ 332.1049, found 332.1050.



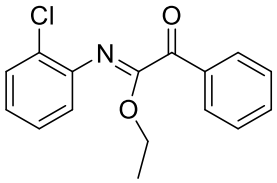
**Ethyl-2-oxo-2-phenyl-*N*-(*o*-tolyl)acetimidate (3ia)**

Yellow oil (m = 46 mg, 87%); **$^{1}$H NMR** (400 MHz, CDCl3) δ: 7.83 (d, *J* = 7.5 Hz, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.06 (d, *J* = 7.1 Hz, 1H), 6.93 – 6.85 (m, 2H), 6.64 (d, *J* = 7.4 Hz, 1H), 4.56 (q, *J* = 7.1 Hz, 2H), 2.27 (s, 3H), 1.49 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, CDCl3) δ: 189.75, 155.84, 143.98, 134.34, 133.81, 130.12, 129.75, 129.29, 128.65, 126.01, 123.86, 120.38, 62.87, 18.09, 14.23. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{17}NO_2H^+$ 268.1332, found 268.1335.



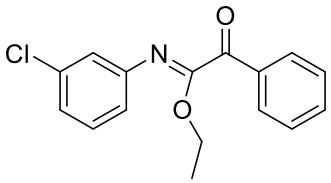
**Ethyl-2-oxo-2-phenyl-*N*-(*m*-tolyl)acetimidate (3ja)**

Yellow oil (m = 45 mg, 84%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.82 (d, *J* = 7.5 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.43 (t, *J* = 7.7 Hz, 2H), 6.99 (t, *J* = 7.7 Hz, 1H), 6.74 (d, *J* = 7.5 Hz, 1H), 6.68 (s, 1H), 6.62 (d, *J* = 7.7 Hz, 1H), 4.50 (q, *J* = 7.1 Hz, 2H), 2.20 (s, 3H), 1.46 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 190.08, 156.66, 145.35, 138.50, 134.34, 133.74, 129.52, 128.70, 128.52, 124.63, 122.31, 118.43, 62.93, 21.19, 14.15. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{17}NO_2H^+$ 268.1332, found 268.1334.



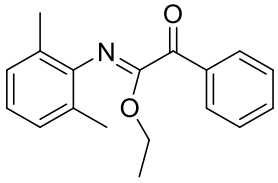

**Ethyl-*N*-(2-chlorophenyl)-2-oxo-2-phenylacetimidate (3ka)**

Yellow oil (m = 51 mg, 89%); **$^{1}$H NMR** (400 MHz, CDCl3) δ: 7.86 (d, *J* = 7.6 Hz, 2H), 7.58 – 7.54 (m, 1H), 7.43 (t, *J* = 7.7 Hz, 2H), 7.22 (dd, $J_1$ = 7.9 Hz, J2 = 1.1 Hz, 1H), 7.04 – 7.00 (m, 1H), 6.88 – 6.82 (m, 2H), 4.59 (q, *J* = 7.1 Hz, 2H), 1.50 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, CDCl3) δ: 188.88, 157.19, 142.69, 134.56, 133.17, 129.51, 129.47, 128.67, 126.99, 126.30, 124.73, 122.62, 63.57, 14.11. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{16}H_{14}ClNO_2H^+$ 288.0786, found 288.0784.



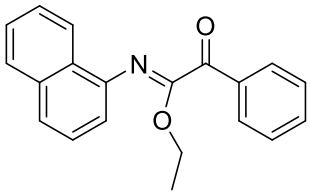

**Ethyl-*N*-(3-chlorophenyl)-2-oxo-2-phenylacetimidate (3la)**

Yellow oil (m = 49 mg, 86%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.81 (d, *J* = 7.6 Hz, 2H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.03 (t, *J* = 7.9 Hz, 1H), 6.89 (t, *J* = 9.5 Hz, 2H), 6.70 (d, *J* = 7.8 Hz, 1H), 4.49 (q, *J* = 7.1 Hz, 2H), 1.45 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.32, 157.42, 146.84, 134.65, 134.21, 133.47, 129.69, 129.47, 128.85, 123.89, 121.84, 119.70, 63.28, 14.07. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{16}H_{14}ClNO_2H^+$ 288.0786, found 288.0788.



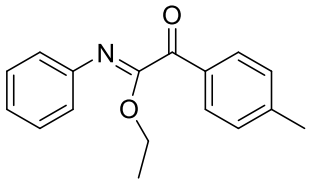

**Ethyl-*N*-(2,6-dimethylphenyl)-2-oxo-2-phenylacetimidate (3ma)**

Yellow oil (m = 40 mg, 72%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.81 (d, *J* = 7.5 Hz, 2H), 7.58 – 7.55 (m, 1H), 7.43 (t, *J* = 7.7 Hz, 2H), 6.91 (d, *J* = 7.6 Hz, 1H), 6.66 (d, *J* = 7.5 Hz, 1H), 6.44 (s, 1H), 4.53 (q, *J* = 7.1 Hz, 2H), 2.20 (s, 3H), 2.10 (s, 3H), 1.48 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.81, 155.62, 143.78, 135.54, 134.26, 133.97, 129.94, 129.31, 128.62, 126.51, 124.55, 121.23, 62.83, 20.73, 17.65, 14.27. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{19}NO_2H^+$ 282.1489, found 282.1492.



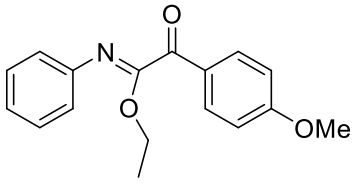
**Ethyl-*N*-(naphthalen-1-yl)-2-oxo-2-phenylacetimidate (3na)**

Yellow solid (m = 56 mg, 93%); m.p. : 76.6-82.5 $^{o}$C; **$^{1}$H NMR** (400 MHz, CDCl3) δ: 8.17 (d, *J* = 8.2 Hz, 1H), 7.74 (d, *J* = 7.6 Hz, 2H), 7.68 (d, *J* = 8.0 Hz, 1H), 7.50 – 7.46 (m, 1H), 7.44 – 7.36 (m, 3H), 7.25 – 7.21 (m, 2H), 7.13 (t, *J* = 7.8 Hz, 1H), 6.78 (d, *J* = 7.2 Hz, 1H), 4.66 (q, *J* = 7.1 Hz, 2H), 1.52 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, CDCl3) δ: 190.01, 156.72, 141.57, 134.26, 133.90, 133.40, 129.11, 128.51, 127.81, 127.71, 126.02, 125.44, 125.38, 124.14, 123.73, 116.17, 63.36, 14.30. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{20}H_{17}NO_2H^+$ 304.1332, found 304.1330.



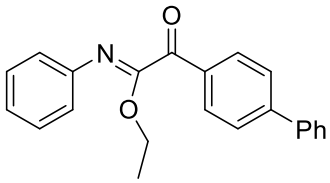
**Ethyl-2-oxo-*N*-phenyl-2-(*p*-tolyl)acetimidate (3oa)**

Yellow oil (m = 45 mg, 85%); **$^{1}$H NMR** (400 MHz, CDCl3) δ: 7.72 (d, *J* = 8.1 Hz, 2 H), 7.22 (d, *J* = 8.0 Hz, 2H), 7.13 (t, *J* = 7.8 Hz, 2H), 6.93 (t, *J* = 7.4 Hz, 1H), 6.85 (d, *J* = 7.7 Hz, 2H), 4.50 (q, *J* = 7.1 Hz, 2H), 2.38 (s, 3H), 1.45 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR** (101 MHz, CDCl3) δ: 189.61, 157.09, 145.65, 145.53, 131.19, 129.66, 129.48, 128.69, 123.73, 121.49, 62.90, 21.79, 14.13. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{17}NO_2H^+$ 268.1332, found 268.1335.



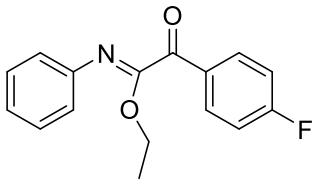
**Ethyl-2-(4-methoxyphenyl)-2-oxo-*N*-phenylacetimidate (3pa)**

Yellow oil (m = 45 mg, 80%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.78 (d, *J* = 8.8 Hz, 2H), 7.13 (t, *J* = 7.7 Hz, 2H), 6.94 – 6.84 (m, 5H), 4.49 (q, *J* = 7.1 Hz, 2H), 3.83 (s, 3H), 1.45 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 188.44, 164.55, 157.25, 145.61, 131.99, 128.68, 126.68, 123.70, 121.47, 114.06, 62.86, 55.48, 14.12. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{17}NO_3H^+$ 284.1281, found 284.1279.



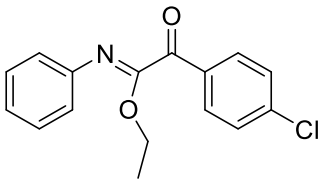

**Ethyl-2-([1,1'-biphenyl]-4-yl)-2-oxo-*N*-phenylacetimidate (3qa)**

Yellow oil (m = 47 mg, 71%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.90 (d, *J* = 8.2 Hz, 2H), 7.66 (d, *J* = 8.4 Hz, 2H), 7.62 – 7.60 (m, 2H), 7.50 – 7.46 (m, 2H), 7.44 – 7.40 (m, 1H), 7.16 (t, *J* = 7.8 Hz, 2H), 6.95 (t, *J* = 7.4 Hz, 1H), 6.89 (d, *J* = 7.7 Hz, 2H) 4.54 (q, *J* = 7.1 Hz, 2H), 1.49 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.59, 156.93, 147.08, 145.50, 139.47, 132.34, 130.12, 128.96, 128.78, 128.51, 127.39, 127.27, 123.85, 121.54, 63.03, 14.17. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{22}H_{19}NO_2H^+$ 330.1489, found 330.1492.



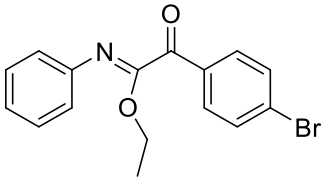

**Ethyl-2-(4-fluorophenyl)-2-oxo-*N*-phenylacetimidate (3ra)**

Yellow oil (m = 38 mg, 71%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.85 – 7.81 (m, 2H), 7.15 – 7.07 (m, 4H), 6.94 (t, *J* = 7.4 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 2H), 4.50 (q, *J* = 7.1 Hz, 2H), 1.46 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 188.45, 166.40 (d, *J* = 258.6 Hz), 156.59, 145.30, 132.26 (d, *J* = 9.7 Hz), 130.07, 128.79, 123.95, 121.43, 116.12 (d, *J* = 22.5 Hz), 63.13, 14.13. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{16}H_{14}FNO_2H^+$ 272.1081, found 272.1082.



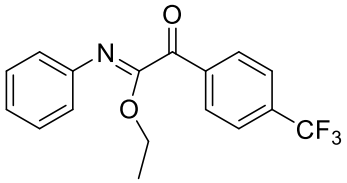

**Ethyl-2-(4-chlorophenyl)-2-oxo-*N*-phenylacetimidate (3sa)**

Yellow solid (m = 46 mg, 81%); m.p. : 52.3 – 56.7 $^{o}$C; **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.74 (d, *J* = 8.4 Hz, 2H), 7.40 (d, *J* = 8.6 Hz, 2H), 7.13 (t, *J* = 7.8 Hz, 2H), 6.94 (t, *J* = 7.4 Hz, 1H), 6.82 (d, *J* = 7.6 Hz, 2H), 4.50 (q, *J* = 7.1 Hz, 2H), 1.46 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 188.84, 156.40, 145.22, 141.02, 131.94, 130.77, 129.18, 128.81, 123.99, 121.42, 63.16, 14.11. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{16}H_{14}ClNO_2H^+$ 288.0785, found 288.0787.



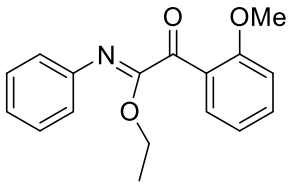

**Ethyl-2-(4-bromophenyl)-2-oxo-*N*-phenylacetimidate (3ta)**

Yellow oil (m = 53 mg, 80%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.66 (d, *J* = 8.5 Hz, 2H), 7.57 (d, *J* = 8.6 Hz, 2H), 7.13 (t, *J* = 7.8 Hz, 2H), 6.95 (t, *J* = 7.4 Hz, 1H), 6.81 (d, *J* = 7.6 Hz, 2H), 4.50 (q, *J* = 7.1 Hz, 2H), 1.45 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.08, 156.37, 145.19, 132.33, 132.17, 130.82, 129.94, 128.83, 124.01, 121.42, 63.18, 14.13. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{16}H_{14}BrNO_2H^+$ 332.0281, found 332.0284.



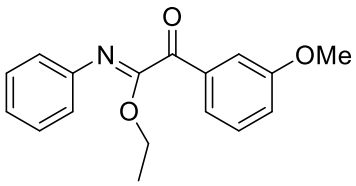

**Ethyl-2-oxo-*N*-phenyl-2-(4-(trifluoromethyl)phenyl)acetimidate (3ua)**

Yellow solid (m = 40 mg, 63%); m.p. : 62.6 - 64.6 °C; **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.91 (d, *J* = 8.1 Hz, 2H), 7.69 (d, *J* = 8.3 Hz, 2H), 7.14 (t, *J* = 7.8 Hz, 2H), 6.95 (t, *J* = 7.4 Hz, 1H), 6.81 (d, *J* = 7.7 Hz, 2H), 4.52 (q, *J* = 7.1 Hz, 2H), 1.47 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.11, 156.07, 145.05, 136.18, 135.40 (q, *J* = 32.9 Hz), 129.73, 128.89, 125.84 (q, *J* = 3.77 Hz), 124.14, 121.42, 63.35, 14.12. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{14}F_3NO_2H^+$ 322.1049, found 322.1051.



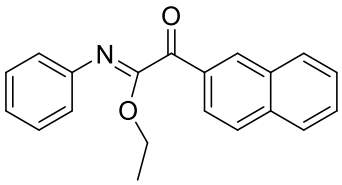

**Ethyl-2-(2-methoxyphenyl)-2-oxo-*N*-phenylacetimidate (3va)**

Yellow oil (m = 50 mg, 89%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.63 (d, *J* = 7.0 Hz, 1H), 7.50 – 7.46 (m, 1H), 7.11 (t, *J* = 7.7 Hz, 2H), 6.92 (q, *J* = 7.9 Hz, 3H), 6.82 (d, *J* = 7.8 Hz, 2H), 4.43 (q, *J* = 7.1 Hz, 2H), 3.95 (s, 3H), 1.43 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 188.32, 159.58, 158.18, 146.37, 135.62, 130.87, 128.57, 124.36, 123.28, 121.49, 120.81, 111.57, 62.76, 55.64, 14.16. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{17}NO_3H^+$ 284.1281, found 284.1282.



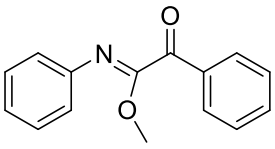

**Ethyl-2-(3-methoxyphenyl)-2-oxo-*N*-phenylacetimidate (3wa)**

Yellow oil (m = 41 mg, 73%); **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 7.40 (d, *J* = 7.6 Hz, 1H), 7.36 – 7.32 (m, 2H), 7.15 – 7.09 (m, 3H), 6.94 (t, *J* = 7.4 Hz, 1H), 6.84 (d, *J* = 7.7 Hz, 2H), 4.50 (q, *J* = 7.1 Hz, 2H), 3.81 (s, 3H), 1.46 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.85, 159.77, 156.82, 145.42, 134.89, 129.75, 128.74, 123.82, 122.77, 121.50, 121.35, 112.66, 63.01, 55.37, 14.13. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{17}NO_3H^+$ 284.1281, found 284.1280.



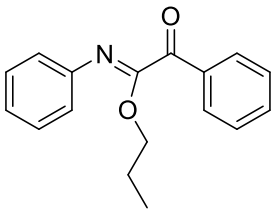

**Ethyl-2-(naphthalen-2-yl)-2-oxo-*N*-phenylacetimidate (3xa)**

White solid (m = 50 mg, 82%); m.p. : 92.3 – 94.6 $^oC$; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.31 (s, 1H), 7.93 (d, *J* = 8.0 Hz, 1H), 7.86 – 7.80 (m, 3H), 7.60 – 7.51 (m, 2H), 7.07 (t, *J* = 7.8 Hz, 2H), 6.87 (d, *J* = 7.2 Hz, 3H), 4.55 (q, *J* = 7.1 Hz, 2H), 1.47 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 190.02, 157.02, 145.52, 136.13, 132.76, 132.26, 130.97, 129.75, 129.23, 128.77, 128.74, 127.83, 126.97, 123.81, 123.67, 121.45, 63.07, 14.16. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{20}H_{17}NO_2H^+$ 304.1332, found 304.1336.



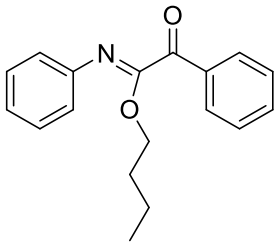

**Methyl-2-oxo-*N*,2-diphenylacetimidate (3ab)**

Yellow oil (m = 35 mg, 73%); **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 7.80 (d, *J* = 7.4 Hz, 2H), 7.58 – 7.55 (m, 1H), 7.43 (t, *J* = 7.7 Hz, 2H), 7.13 (t, *J* = 7.8 Hz, 2H), 6.94 (t, *J* = 7.4 Hz, 1H), 6.84 (d, *J* = 7.6 Hz, 2H ), 4.04 (s, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.91, 157.21, 145.22, 134.51, 133.56, 129.52, 128.76, 123.95, 121.48, 54.03. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{15}H_{13}NO_2H^+$ 240.1019, found 240.1021.



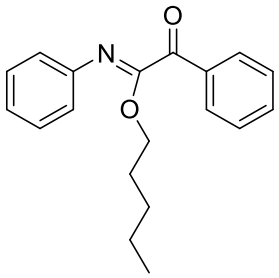
**Propyl-2-oxo-*N*,2-diphenylacetimidate (3ac)**

Yellow oil (m = 43 mg, 81%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.82 (d, *J* = 7.5 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.8 Hz, 2H), 7.13 (t, *J* = 7.8 Hz, 2H), 6.93 (t, *J* = 7.4 Hz, 1H), 6.84 (d, *J* = 7.7 Hz, 2H ), 4.41 (t, *J* = 6.7 Hz, 2H), 1.91 – 1.82 (m, 2H), 1.05 (t, *J* = 7.4 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.98, 157.08, 145.45, 134.41, 133.65, 129.50, 128.73, 128.72, 123.79, 121.48, 68.70, 21.87, 10.50. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{17}NO_2H^+$ 268.1332, found 268.1330.



**Butyl-2-oxo-*N*,2-diphenylacetimidate (3ad)**

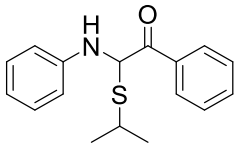
Yellow oil (m = 44 mg, 78%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.81 (d, *J* = 7.6 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.43 (t, *J* = 7.7 Hz, 2H), 7.12 (t, *J* = 7.7 Hz, 2H), 6.93 (t, *J* = 7.3 Hz, 1H), 6.84 (d, *J* = 7.7 Hz, 2H ), 4.45 (t, *J* = 6.7 Hz, 2H), 1.85 – 1.78 (m, 2H), 1.54 – 1.45 (m, 2H), 0.99 (t, *J* = 7.4 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 190.05, 157.16, 145.51, 134.47, 133.70, 129.56, 128.78, 123.85, 121.55, 67.04, 30.60, 19.27, 13.81. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{19}NO_2H^+$ 282.1489, found 282.1491.



**Pentyl-2-oxo-*N*,2-diphenylacetimidate (3ae)**

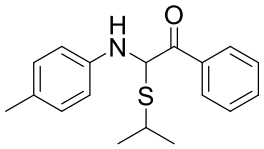
Yellow oil (m = 31 mg, 52%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 7.81 (d, *J* = 7.5 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.43 (t, *J* = 7.7 Hz, 2H), 7.12 (t, *J* = 7.8 Hz, 2H), 6.93 (t, *J* = 7.4 Hz,

1H), 6.83 (d, *J* = 7.6 Hz, 2H ), 4.44 (t, *J* = 6.7 Hz, 2H), 1.87 – 1.80 (m, 2H), 1.43 – 1.41 (m, 4H), 0.94 (t, *J* = 7.1 Hz, 3H); **$^{13}$C NMR (101 MHz, CDCl$_3$)** δ: 190.00, 157.10, 145.47, 134.41, 133.68, 129.52, 128.73, 123.80, 121.51, 67.26, 28.20, 28.12, 22.34, 13.95. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{19}H_{21}NO_2H^+$ 296.1644, found 296.1646.



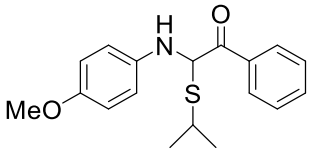
**2-(Isopropylthio)-1-phenyl-2-(phenylamino)ethan-1-one (5aa)**

Yellow solid (m = 31 mg, 91 %); m.p. : 94.5 – 97.9 °C; **$^1$H NMR (400 MHz, CDCl$_3$)** δ: 8.08 – 8.05 (m, 2H), 7.64 – 7.60 (m, 1H), 7.52 (t, *J* = 7.6 Hz, 2H), 730 – 7.26 (m, 2H), 6.92 – 6.89 (m, 2H), 6.85 (t, *J* = 7.3 Hz, 1H ), 6.06 (s, 1H), 5.36 (s, 1H), 2.97 – 2.87 (m, 1H), 1.13 – 1.11 (m, 6H); **$^{13}$C NMR (101 MHz, CDCl$_3$)** δ: 191.02, 143.73, 134.22, 133.56, 129.26, 128.72, 128.62, 118.78, 114.33, 59.84, 33.06, 25.06, 24.36. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{19}NOSH^+$ 286.1260, found 286.1265.



**2-(Isopropylthio)-1-phenyl-2-(*p*-tolylamino)ethan-1-one (5ba)**

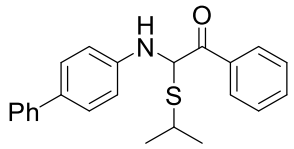
Yellow solid (m = 51 mg, 86%); m.p. : 90.0 – 92.8 °C; **$^1$H NMR (400 MHz, CDCl$_3$)** δ: 8.04 – 8.01 (m, 2H), 7.58 – 7.54 (m, 1H), 7.48 – 7.44 (m, 2H), 7.06 (d, *J* = 8.1 Hz, 2H), 6.80 – 6.78 (m, 2H), 6.03 (d, *J* = 7.2 Hz, 1H ), 5.22 (d, *J* = 6.8 Hz, 1H), 2.93 – 2.83 (m, 1H), 2.26 (s, 3H), 1.08 (q, *J* = 3.5 Hz, 6H); **$^{13}$C NMR (101 MHz, CDCl$_3$)** δ: 190.94, 141.32, 134.26, 133.42, 129.74, 128.63, 128.56, 127.92, 114.39, 60.18, 32.93, 25.05, 24.34, 20.44. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{21}NOSH^+$ 300.1417, found 300.1419.



**2-(Isopropylthio)-2-((4-methoxyphenyl)amino)-1-phenylethan-1-one (5ca)**

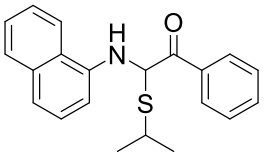
Yellow solid (m = 41 mg, 65%); m.p. : 99.2 – 98.6 °C; **$^1$H NMR (400 MHz, CDCl$_3$)** δ: 8.07 – 8.05 (m, 2H), 7.53 – 7.59 (m, 1H), 7.53 – 7.49 (m, 2H), 7.09 (d, *J* = 8.1 Hz, 2H), 6.83 (d, *J*

= 8.4 Hz, 2H), 6.06 (d, *J* = 7.8 Hz, 1H ), 5.22 (d, *J* = 7.7 Hz, 1H), 2.96 – 2.86 (m, 1H), 2.29 (s, 3H), 1.12 (q, J = 3.6 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 191.06, 141.39, 134.34, 133.49, 129.80, 128.70, 128.61, 128.03, 114.43, 60.27, 33.03, 25.09, 24.38, 20.48. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{21}NO_2SH^+$ 316.1366, found 316.1365.



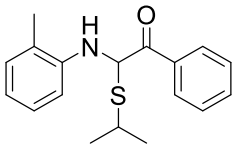

**2-([1,1'-Biphenyl]-4-ylamino)-2-(isopropylthio)-1-phenylethan-1-one (5da)**

Yellow solid (m = 64 mg, 85%); m.p. : 68.1 – 74.6 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.10 (d, *J* = 7.5 Hz, 2H), 7. 65 – 7.60 (m, 3H), 7.57 – 7.52 (m, 4H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.31 (t, *J* = 7.3 Hz, 1H), 6.99 (d, *J* = 8.4 Hz, 2H ), 6.12 (d, *J* = 7.8 Hz, 1H), 5.48 (d, *J* = 7.2 Hz, 1H), 3.01 - 2.91 (m, 1H), 1.16 (t, *J* = 7.0 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 191.03, 143.17, 141.06, 134.20, 133.69, 131.72, 128.80, 128.72, 127.99, 126.43, 126.35, 114.67, 59.85, 33.20, 25.18, 24.44. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{23}H_{23}NOSH^+$ 362.1573, found 362.1575.



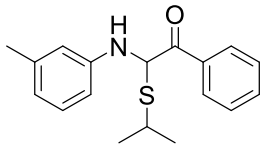

**2-(Isopropylthio)-2-(naphthalen-1-ylamino)-1-phenylethan-1-one (5ea)**

Yellow solid (m = 56 mg, 83%); m.p. : 68.8 – 72.5 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.15 – 8.13 (m, 2H), 8.04 – 8.02 (m, 1H), 7.87 – 7.85 (m, 1H), 7.66 – 7.62 (m, 1H), 7.56 – 7.51 (m, 4H), 7.46 (t, *J* = 7.9 Hz, 1H), 7.37 (d, *J* = 8.2 Hz, 1H ), 7.01 (d, *J* = 7.4 Hz, 1H), 6.22 (s, 2H), 3.02 - 2.91 (m, 1H), 1.15 (d, *J* = 6.8 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 191.28, 138.75, 134.34, 134.13, 133.65, 128.75, 128.71, 126.31, 125.87, 125.15, 123.56, 119.74, 118.67, 107.00, 59.86, 33.24, 24.98, 24.39. HRMS (EI) $[M+Na]^+$ m/z Calcd for $C_{21}H_{21}NOSNa^+$ 358.1236, found 358.1238.



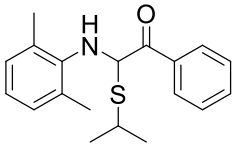
**2-(Isopropylthio)-1-phenyl-2-(*o*-tolylamino)ethan-1-one (5fa)**

Yellow oil (m = 54 mg, 90%); **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.09 – 8.07 (m, 2H), 7.65 – 7.61 (m, 1H), 7.54 – 7.51 (m, 2H), 7.23 (t, *J* = 7.7 Hz, 1H), 7.14 (d, *J* = 7.3 Hz, 1H), 7.01 (d, *J* = 7.9 Hz, 1H), 6.81 – 6.78 (m, 1H), 6.10 (d, J = 7.7 Hz, 1H), 5.34 (d, J = 7.6 Hz, 1H), 2.93 - 2.86 (m, 1H), 2.30 (s, 3H), 1.12 (q, *J* = 6.7 Hz, 6H), 1.06 (d, *J* = 6.9 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 191.23, 141.73, 134.19, 133.56, 130.30, 128.72, 128.62, 126.99, 122.81, 118.34, 111.97, 59.70, 33.09, 24.90, 24.40, 17.37. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{21}NOSH^+$ 300.1417, found 300.1419.



**2-(Isopropylthio)-1-phenyl-2-(*m*-tolylamino)ethan-1-one (5ga)**

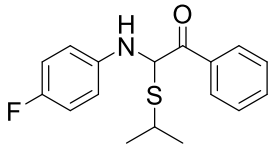
Yellow soild (m = 42 mg, 75%); m.p. : 96.5 – 102.2 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.08 – 8.06 (m, 2H), 7.64 – 7.59 (m, 1H), 7.53 – 7.49 (m, 2H), 7.19 – 7.15 (m, 1H), 6.73 – 6.66 (m, 3H ), 6.06 (s, 1H), 5.30 (s, 1H), 2.98 - 2.87 (m, 1H), 2.35 (s, 3H), 1.13 (t, *J* = 6.7 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 191.05, 143.77, 139.06, 134.26, 133.51, 129.11, 128.70, 128.62, 119.72, 115.05, 111.42, 59.94, 33.10, 25.07, 24.36, 21.62. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{21}NOSH^+$ 300.1417, found 300.1416.



**2-((2,6-Dimethylphenyl)amino)-2-(isopropylthio)-1-phenylethan-1-one (5ha)**

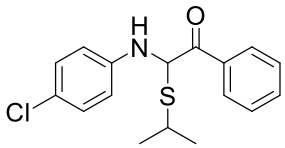
Yellow solid (m = 54 mg, 87%); m.p. : 64.7 – 72.2 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.11 – 8.09 (m, 2H), 7.63 (t, *J* = 7.4 Hz, 1H), 7.53 (t, *J* = 7.5 Hz, 2H), 7.02 (d, *J* = 7.4 Hz, 1H), 6.83 (s, 1H ), 6.62 (d, *J* = 7.4 Hz, 1H), 6.10 (d, *J* = 7.6 Hz, 1H), 5.30 (d, *J* = 7.6 Hz, 1H), 2.96 – 2.86 (m, 1H), 2.39 (s, 3H), 2.26 (s, 3H), 1.15 – 1.11 (m, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 191.21, 141.60, 136.59, 134.23, 133.52, 130.12, 128.70, 128.63, 119.81, 119.01, 112.78,

59.78, 33.14, 24.93, 24.39, 21.54, 16.92. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{19}H_{23}NOSH^+$ 314.1573, found 314.1572.



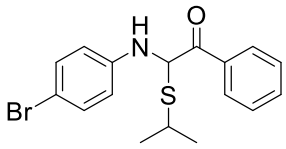

**2-((4-fluorophenyl)amino)-2-(isopropylthio)-1-phenylethan-1-one (5ia)**

Yellow solid (m = 46 mg, 76%); m.p. : 92.3 – 94.6 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.10 – 8.07 (m, 2H), 7.28 – 7.24 (m, 2H), 7.16 (t, *J* = 8.5 Hz, 2H), 6.88 – 6.81 (m, 3H ), 5.99 (d, *J* = 7.9 Hz, 1H), 5.31 (d, J = 7.7 Hz, 1H), 2.94 - 2.83 (m, 1H), 1.09 (t, *J* = 6.4 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.61, 165.92 (d, *J* = 256.9 Hz), 143.62, 131.35 (d, *J* = 9.6 Hz), 130.44 (d, *J* = 3.0 Hz), 129.27, 118.87, 115.91 (d, *J* = 22.1 Hz), 114.33, 59.86, 33.11, 25.05, 24.35. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{18}FNOSH^+$ 304.1165, found 304.1167.




**2-((4-Chlorophenyl)amino)-2-(isopropylthio)-1-phenylethan-1-one (5ja)**

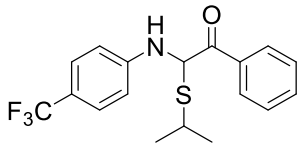
Yellow solid (m = 53 mg, 84%); m.p. : 108.5 – 113.7 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.07 – 8.04 (m, 2H), 7.64 – 7.60 (m, 1H), 7.53 – 7.49 (m, 2H), 7.27 – 7.21 (m, 2H), 6.85 – 6.81 (m, 2H ), 5.99 (d, *J* = 4.5 Hz, 1H), 5.41 (d, *J* = 4.9 Hz, 1H), 2.93 - 2.82 (m, 1H), 1.10 (d, *J* = 6.8 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 190.81, 142.25, 133.99, 133.67, 129.13, 128.72, 128.62, 123.50, 115.44, 59.66, 33.05, 25.04, 24.32. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{18}ClNOSH^+$ 320.0871, found 320.0873.




**2-((4-Bromophenyl)amino)-2-(isopropylthio)-1-phenylethan-1-one (5ka)**

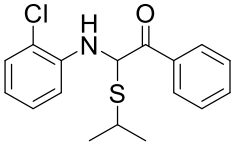
Yellow solid (m = 63 mg, 87%); m.p. : 79.5 – 84.1 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 7.91 (d, *J* = 8.6 Hz, 2H), 7.63 (d, *J* = 8.6 Hz, 2H), 7.28 – 7.24 (m, 2H), 6.88 – 6.81 (m, 3H), 5.97 (d, *J* = 7.9 Hz, 1H), 5.30 (d, *J* = 7.8 Hz, 1H), 2.91 – 2.81 (m, 1H), 1.10 – 1.07 (m, 6H); **$^{13}$C**

**NMR (101 MHz, $CDCl_3$)** δ:189.94, 143.53, 132.93, 132.05, 130.12, 129.28, 128.71, 118.92, 114.33, 59.89, 33.11, 25.04, 24.34. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{18}BrNOSH^+$ 364.0365, found 364.0366.



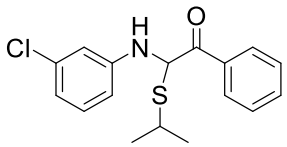
**2-(Isopropylthio)-1-phenyl-2-((4-(trifluoromethyl)phenyl)amino)ethan-1-one (5la)**

Yellow solid (m = 54 mg, 76%); m.p. : 110.9 – 113.9 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.09 – 8.07 (m, 2H), 7.66 – 7.62 (m, 1H), 7.53 (t, *J* = 7.7 Hz, 4H), 6.93 (d, *J* = 8.6 Hz, 2H), 6.04 (d, *J* = 7.4 Hz, 1H), 5.72 (d, *J* = 7.4 Hz, 1H), 2.95 – 2.85 (m, 1H), 1.11 (d, *J* = 6.8 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ:190.80, 146.35, 133.84, 128.79, 128.70, 126.59 (q, *J* = 3.8 Hz), 126.15, 123.46, 120.41 (d, J = 32.8 Hz), 113.70, 59.04, 33.27, 25.02, 24.27. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{18}F_3NOSH^+$ 354.1134, found 354.1136.



**2-((2-Chlorophenyl)amino)-2-(isopropylthio)-1-phenylethan-1-one (5ma)**

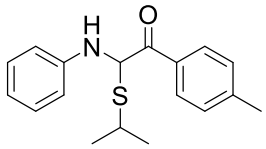
Yellow oil (m = 54 mg, 85%); **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.09 – 8.07 (m, 2H), 7.65 – 7.60 (m, 1H), 7.54 – 7.50 (m, 2H), 7.35 – 7.32 (m, 1H), 7.27 – 7.23 (m, 1H ), 7.06 – 7.04 (m, 1H), 6.80 – 6.76 (m, 1H), 6.10 (d, *J* = 7.6 Hz, 1H), 6.05 (d, *J* = 7.6 Hz, 1H), 2.95 – 2.85 (m, 1H), 1.12 – 1.08 (m, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 190.53, 139.85, 133.99, 133.65, 129.30, 128.73, 128.67, 127.58, 120.31, 118.81, 113.69, 59.22, 33.17, 24.94, 24.36. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{18}ClNOSH^+$ 320.0871, found 320.0870.



**2-((3-Chlorophenyl)amino)-2-(isopropylthio)-1-phenylethan-1-one (5na)**

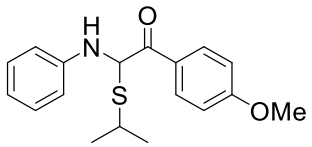
Yellow solid (m = 55 mg, 86%); m.p. : 77.7 – 81.5 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.07 – 8.05 (m, 2H), 7.64 – 7.60 (m, 1H), 7.53 – 7.50 (m, 2H), 7.17 (t, *J* = 8.0 Hz, 1H), 6.91 (t, *J* = 2.1 Hz, 1H ), 6.82 – 6.75 (m, 2H), 5.99 (d, *J* = 7.7 Hz, 1H), 5.49 (d, *J* = 7.6 Hz, 1H), 2.94 – 2.84 (m, 1H), 1.12 (t, *J* = 6.4 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 190.77, 144.88, 134.96, 133.89, 133.70, 130.19, 128.73, 128.66, 118.63, 114.05, 112.61, 59.36, 33.15, 25.05,

24.30. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{18}ClNOSH^+$ 320.0871, found 320.0873.



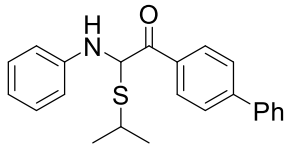
**2-(Isopropylthio)-2-(phenylamino)-1-(*p*-tolyl)ethan-1-one (5oa)**

Yellow solid (m = 50 mg, 84%); m.p. : 97.3 – 100.6 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 7.97 (d, *J* = 8.4 Hz, 2H), 7.32 – 7.26 (m, 4H), 6.91 (d, *J* = 7.7 Hz, 2H), 6.84 (t, *J* = 7.3 Hz, 1H ), 6.05 (d, *J* = 7.6 Hz, 1H), 5.38 (d, *J* = 7.6 Hz, 1H), 2.98 – 2.88 (m, 1H), 2.45 (s, 3H), 1.12 (dd, $J_1$ = 6.9 Hz, $J_2$ = 2.9 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 190.81, 144.53, 143.79, 131.54, 129.42, 129.22, 128.73, 118.67, 114.29, 59.68, 32.99, 25.05, 24.38, 21.69. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{21}NOSH^+$ 300.1417, found 300.1420.



**2-(Isopropylthio)-1-(4-methoxyphenyl)-2-(phenylamino)ethan-1-one (5pa)**

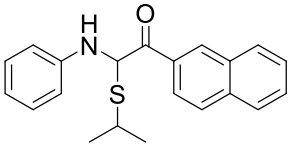
Yellow solid (m = 42 mg, 66%); m.p. : 108.3 – 111.5 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.05 – 8.03 (m, 2H), 7.27 – 7.23 (m, 2H), 6.98 – 6.95 (m, 2H), 6.88 – 6.86 (m, 2H ), 6.81 (t, *J* = 7.3 Hz, 1H), 6.00 (d, *J* = 7.8 Hz, 1H), 5.35 (d, J = 7.8 Hz, 1H), 3.88 (s, 3H), 2.97 – 2.86 (m, 1H), 1.10 (t, *J* = 6.5 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 190.04, 163.93, 143.90, 131.01, 129.24, 126.77, 118.63, 114.31, 113.96, 59.56, 55.50, 33.06, 25.08, 24.42. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{21}NO_2SH^+$ 316.1366, found 316.1364.



**1-([1,1'-Biphenyl]-4-yl)-2-(isopropylthio)-2-(phenylamino)ethan-1-one (5qa)**

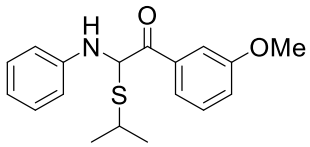
Yellow oil (m = 52 mg, 72%); m.p. : 164.5 – 168.3 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.16 (d, *J* = 8.3 Hz, 2H), 7.74 (d, *J* = 8.5 Hz, 2H), 7.68 – 7.66 (m, 2H), 7.52 – 7.49 (m, 2H), 7.45 – 7.42 (m, 1H ), 7.31 (t, *J* = 7.6 Hz, 2H), 6.94 (d, *J* = 8.3 Hz, 2H), 6.87 (t, *J* = 7.3 Hz, 1H), 6.12 (d, *J* = 6.8 Hz, 1H), 5.42 (d, *J* = 6.8 Hz, 1H), 3.02 – 2.94 (m, 1H), 1.16 (d, *J* = 6.9 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 190.56, 146.25, 143.73, 139.67, 132.80, 129.25, 129.21,

128.93, 128.31, 127.31, 127.24, 118.76, 114.33, 59.84, 33.06, 25.06, 24.40. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{23}H_{23}NOSH^+$ 362.1573, found 362.1574.



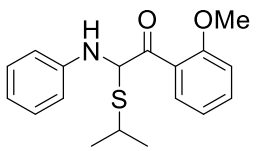
**2-(Isopropylthio)-1-(naphthalen-2-yl)-2-(phenylamino)ethan-1-one (5ra)**

Yellow solid (m = 62 mg, 92%); m.p. : 74.1 – 78.5 $^oC$; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.62 (s, 1H), 8.12 – 8.09 (m, 1H), 8.00 (d, *J* = 8.0 Hz, 1H), 7.95 (d, *J* = 8.7 Hz, 1H), 7.90 (d, *J* = 8.0 Hz, 1H ), 7.65 – 7.56 (m, 2H), 7.34 – 7.30 (m, 2H), 6.98 (d, *J* = 8.4 Hz, 2H), 6.88 (t, *J* = 7.3 Hz, 1H), 6.23 (d, *J* = 2.6 Hz, 1H), 5.47 (s, 1H), 3.03 – 2.93 (m, 1H), 1.14 (t, *J* = 7.0 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 190.91, 143.75, 135.78, 132.44, 131.43, 130.19, 129.64, 129.26, 128.70, 128.56, 127.76, 126.87, 124.24, 118.77, 114.38, 59.96, 33.08, 25.07, 24.39. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{21}H_{21}NOSH^+$ 336.1417, found 336.1420.



**2-(Isopropylthio)-1-(3-methoxyphenyl)-2-(phenylamino)ethan-1-one (5sa)**

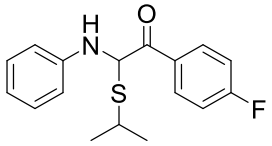
Yellow oil (m = 54 mg, 86%); **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 7.64 – 7.60 (m, 2H), 7.42 (t, *J* = 7.9 Hz, 1H), 7.30 – 7.26 (m, 2H), 7.17 – 7.15 (m, 1H ), 6.91 (d, *J* = 7.7 Hz, 2H), 6.85 (t, *J* = 7.3 Hz, 1H), 6.10 (d, *J* = 4.5 Hz, 1H), 5.35 (s, 1H), 3.89 (s, 3H), 2.97 – 2.87 (m, 1H), 1.13 (q, *J* = 3.5 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ:190.81, 159.87, 143.69, 135.59, 129.66, 129.23, 120.86, 119.77, 118.76, 114.30, 113.36, 59.89, 55.43, 33.05, 25.00, 24.36. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{21}NO_2SH^+$ 316.1366, found 316.1368.



**2-(Isopropylthio)-1-(2-methoxyphenyl)-2-(phenylamino)ethan-1-one (5ta)**

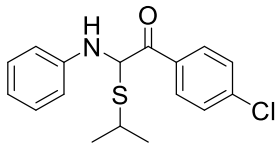
Yellow oil (m = 40 mg, 63%); m.p. : 72.0 – 76.4 $^oC$; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 7.93 – 7.91 (m, 1H), 7.53 – 7.48 (m, 1H), 7.25 (t, *J* = 7.9 Hz, 2H), 7.08 – 7.04 (m, 1H ), 6.98 (d, *J* = 8.3 Hz, 1H), 6.86 (d, *J* = 7.7 Hz, 2H), 6.80 (t, *J* = 7.3 Hz, 1H), 6.29 (d, J = 7.2 Hz, 1H), 5.43

(d, *J* = 7.2 Hz, 1H), 3.94 (s, 3H), 2.87 – 2.77 (m, 1H), 1.09 (d, *J* = 6.8 Hz, 3H), 1.05 (d, J = 6.9 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 192.04, 158.29, 144.11, 134.06, 131.87, 129.20, 124.84, 121.05, 118.37, 114.14, 111.77, 64.16, 55.73, 32.22, 24.99, 24.27. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{21}NO_2SH^+$ 316.1366, found 316.1367.



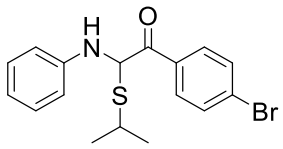
**1-(4-Fluorophenyl)-2-(isopropylthio)-2-(phenylamino)ethan-1-one (5ua)**

Yellow solid (m = 49 mg, 81%); m.p. : 92.9 – 98.2 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.12 – 8.09 (m, 2H), 7.30 – 7.26 (m, 2H), 7.20 – 7.16 (m, 2H), 6.90 – 6.83 (m, 3H ), 6.01 (s, 1H), 5.32 (s, 1H), 2.96 - 2.85 (m, 1H), 1.11 (t, *J* = 6.5 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.65, 165.94 (q, J = 257.0 Hz), 143.65, 131.36 (q, J = 9.3 Hz), 130.46 (q, J = 3.2 Hz), 129.29, 118.89, 115.92, (q, J = 22.1 Hz), 114.35, 59.89, 33.14, 25.05, 24.35. HRMS (EI) $[M+Na]^+$ m/z Calcd for $C_{17}H_{18}FNOSNa^+$ 326.0985, found 326.0988.



**1-(4-Chlorophenyl)-2-(isopropylthio)-2-(phenylamino)ethan-1-one (5va)**

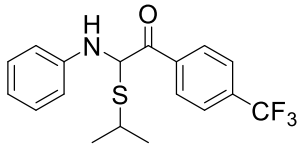
Yellow solid (m = 51 mg, 80%); m.p. : 98.7 – 101.6°C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.02 – 8.00 (m, 2H), 7.50 – 7.47 (m, 2H), 7.30 – 7.26 (m, 2H), 6.91 – 6.84 (m, 3H ), 6.01 (d, *J* = 7.8 Hz, 1H), 5.33 (d, *J* = 7.6 Hz, 1H), 2.94 - 2.84 (m, 1H), 1.13 – 1.10 (m, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.76, 143.54, 139.97, 132.49, 130.04, 129.27, 129.04, 118.90, 114.32, 59.89, 33.09, 25.04, 24.33. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{18}ClNOSH^+$ 320.0871, found 320.0873.



**1-(4-Bromophenyl)-2-(isopropylthio)-2-(phenylamino)ethan-1-one (5wa)**

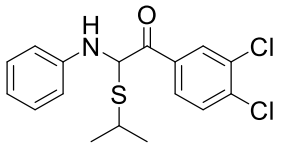
Yellow solid (m = 64 mg, 88%); m.p. : 94.1 – 100.7 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 7.94 – 7.92 (m, 2H), 7.66 – 7.64 (m, 2H), 7.31 – 7.26 (m, 2H), 6.91 – 6.83 (m, 3H ), 6.00 (s, 1H), 5.32 (s, 1H), 2.94 - 2.84 (m, 1H), 1.12 – 1.09 (m, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.94, 143.53, 132.94, 132.03, 130.11, 129.27, 128.69, 118.92, 114.33, 59.89, 33.11, 25.03,

24.33. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{18}BrNOSH^+$ 364.0365, found 364.0366.



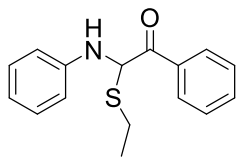
**2-(Isopropylthio)-2-(phenylamino)-1-(4-(trifluoromethyl)phenyl)ethan-1-one (5xa)**

Yellow solid (m = 49 mg, 70%); m.p. : 84.8 – 88.3 $^oC$; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.17 (d, *J* = 8.2 Hz, 2H), 7.78 (d, *J* = 8.3 Hz, 2H), 7.32 – 7.28 (m, 2H), 6.92 (d, J = 7.7 Hz, 2H), 6.87 (t, *J* = 7.34, 1H ), 6.06 (d, *J* = 7.8 Hz, 1H), 5.34 (d, *J* = 7.8 Hz, 1H), 2.95 - 2.84 (m, 1H), 1.13 – 1.11 (m, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.61, 143.42, 137.23, 134.69 (q, *J* = 33.0 Hz), 129.32, 128.95, 125.75 (q, *J* = 3.6 Hz), 119.09, 114.38, 60.24, 33.14, 25.01, 24.28. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{18}F_3NOSH^+$ 354.1134, found 354.1133.



**1-(3,4-Dichlorophenyl)-2-(isopropylthio)-2-(phenylamino)ethan-1-one (5ya)**

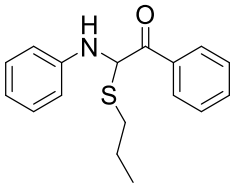
Yellow solid (m = 61 mg, 86%); m.p. : 83.8 – 87.5 $^oC$; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.16 (d, *J* = 2.0 Hz, 1H), 7.87 (dd, $J_1$ = 8.4 Hz, $J_2$ = 2.1 Hz, 1H), 7.58 (d, *J* = 8.4 Hz, 1H), 7.31 – 7.27 (m, 2H), 6.91 – 6.84 (m, 3H), 5.97 (s, 1H), 5.30 (s, 1H), 2.92 - 2.82 (m, 1H), 1.13 (q, *J* = 3.5 Hz, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 188.53, 143.32, 138.05, 133.81, 133.45, 130.75, 130.58, 129.28, 127.55, 119.05, 114.35, 59.99, 33.16, 25.01, 24.30. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{17}Cl_2NOSH^+$ 354.0481, found 354.0483.



**2-(Ethylthio)-1-phenyl-2-(phenylamino)ethan-1-one (5ab)**

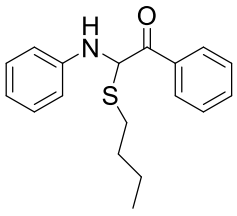
Yellow solid (m = 38 mg, 70%); m.p.: 64.5 – 66.9 $^oC$; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.09 – 8.07 (m, 2H), 7.64 – 7.61 (m, 1H), 7.52 (t, *J* = 7.6 Hz, 2H), 7.32 – 7.27 (m, 2H ), 6.92 (d, *J* = 7.7 Hz, 2H), 6.86 (t, *J* = 7.3 Hz, 1H), 6.07 (d, *J* = 7.7 Hz, 1H), 5.37 (d, *J* = 7.7 Hz, 1H), 2.41 - 2.33 (m, 2H), 1.08 (t, *J* = 7.5 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.79, 143.43,

134.00, 133.58, 129.26, 128.71, 128.60, 118.83, 114.36, 59.03, 21.11, 13.96. HRMS (EI) $[M+Na]^+$ m/z Calcd for $C_{16}H_{17}NOSNa^+$ 294.0923, found 294.0925.



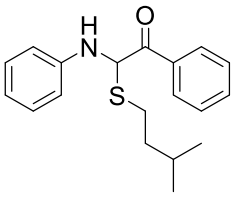
**1-Phenyl-2-(phenylamino)-2-(propylthio)ethan-1-one (5ac)**

Yellow solid (m = 36 mg, 64%); m.p.: 68.9 – 72.2 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.08 – 8.06 (m, 2H), 7.64 – 7.60 (m, 1H), 7.54 – 7.50 (m, 2H), 7.31 – 7.27 (m, 2H ), 6.92 (d, *J* = 7.7 Hz, 2H), 6.86 (t, *J* = 7.3 Hz, 1H), 6.06 (d, *J* = 7.6 Hz, 1H), 5.35 (d, *J* = 7.5 Hz, 1H), 2.34 - 2.29 (m, 2H), 1.46 – 1.37 (m, 2H),0.82 (t, *J* = 7.3 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.82, 143.45, 134.07, 133.56, 129.25, 128.71, 128.60, 118.83, 114.40, 58.93, 28.94, 22.38, 13.58. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{17}H_{19}NOSH^+$ 286.1259, found 286.1260.



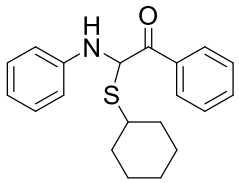
**2-(Butylthio)-1-phenyl-2-(phenylamino)ethan-1-one (5ad)**

Yellow solid (m = 40 mg, 67%); m.p.: 65.0 – 66.9 °C; **$^1$H NMR (400 MHz, $CDCl_3$)** δ: 8.08 – 8.06 (m, 2H), 7.64 – 7.60 (m, 1H), 7.52 (t, *J* = 7.6 Hz, 2H), 7.31 – 7.27 (m, 2H ), 6.92 (d, *J* = 7.8 Hz, 2H), 6.86 (t, *J* = 7.3 Hz, 1H), 6.06 (d, *J* = 7.7 Hz, 1H), 5.34 (d, *J* = 7.6 Hz, 1H), 2.37 - 2.30 (m, 2H), 1.41 – 1.33 (m, 2H), 1.28 – 1.19 (m, 1H), 0.78 (t, *J* = 7.3 Hz, 3H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.77, 143.45, 134.08, 133.54, 129.24, 128.70, 128.59, 118.82, 114.40, 58.95, 30.88, 26.60, 22.05, 13.44. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{18}H_{21}NOSH^+$ 300.1417, found 300.1419.



**2-(Isopentylthio)-1-phenyl-2-(phenylamino)ethan-1-one (5ae)**

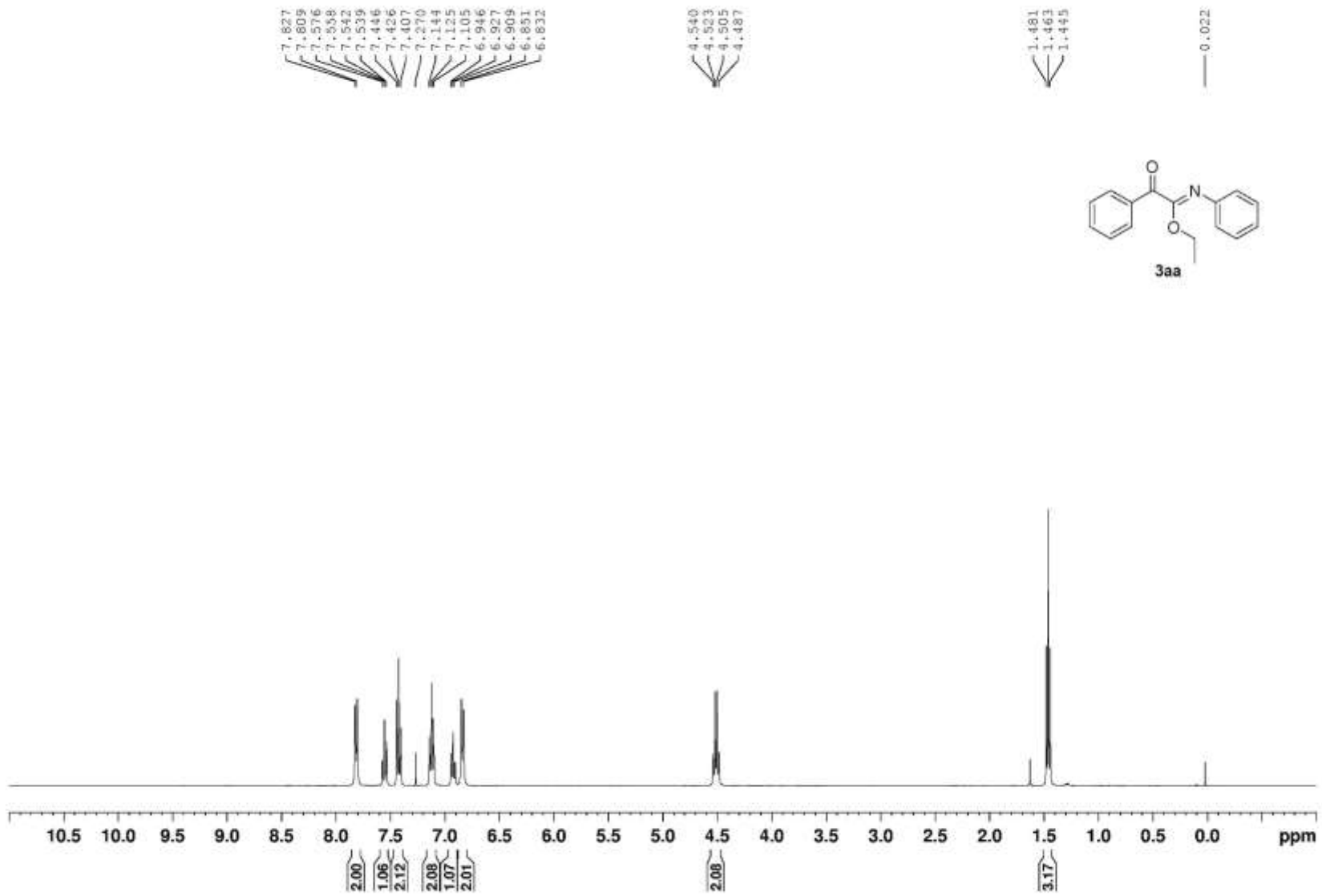
Yellow oil (m = 46 mg, 74%); **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 8.05 – 8.03 (m, 2H), 7.61 – 7.57 (m, 1H), 7.51 – 7.47 (m, 2H), 7.28 – 7.24 (m, 2H ), 6.90 – 6.88 (m, 2H), 6.83 (t, *J* = 7.3 Hz, 1H), 6.03 (d, *J* = 8.1 Hz, 1H), 5.32 (d, *J* = 8.0 Hz, 1H), 2.35 - 2.28 (m, 2H), 1.52 – 1.42 (m, 1H), 1.27 – 1.21 (m, 2H), 0.75 – 0.72 (m, 6H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 189.74, 143.45, 134.09, 133.54, 129.24, 128.70, 128.58, 118.84, 114.41, 58.96, 37.62, 27.45, 25.00, 22.04. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{19}H_{23}NOSH^+$ 314.1573, found 314.1571.

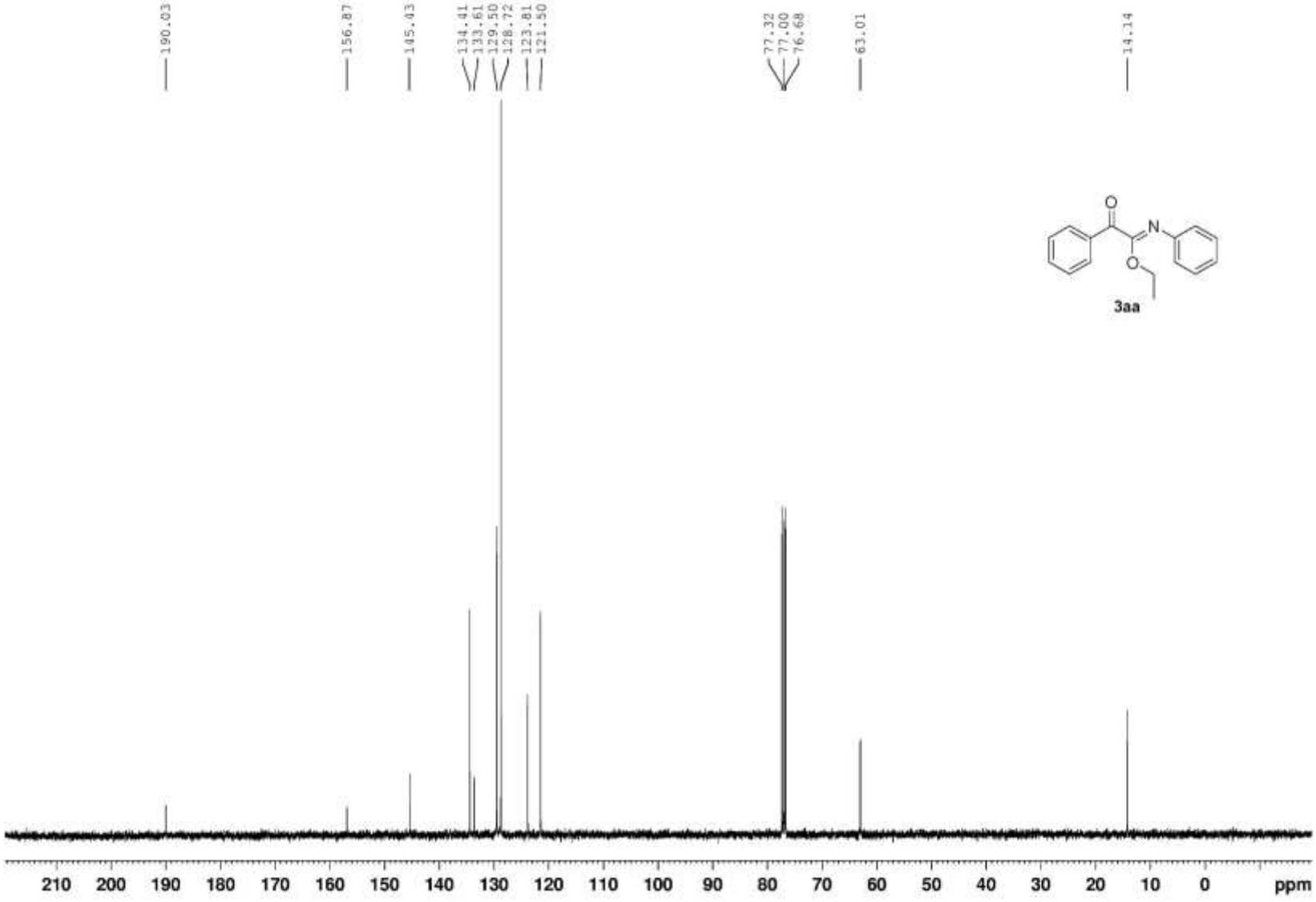


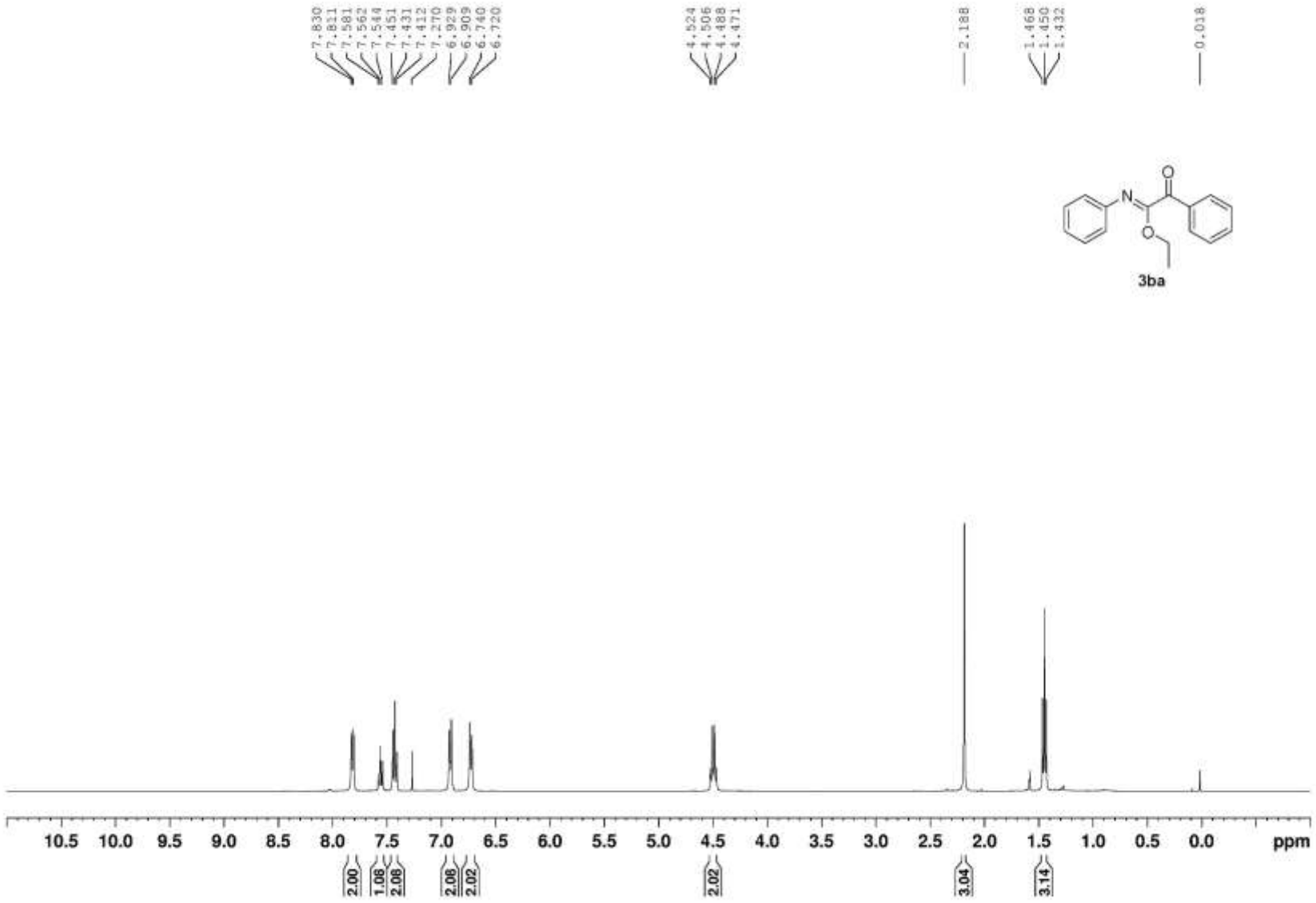

**2-(Cyclohexylthio)-1-phenyl-2-(phenylamino)ethan-1-one (5af)**

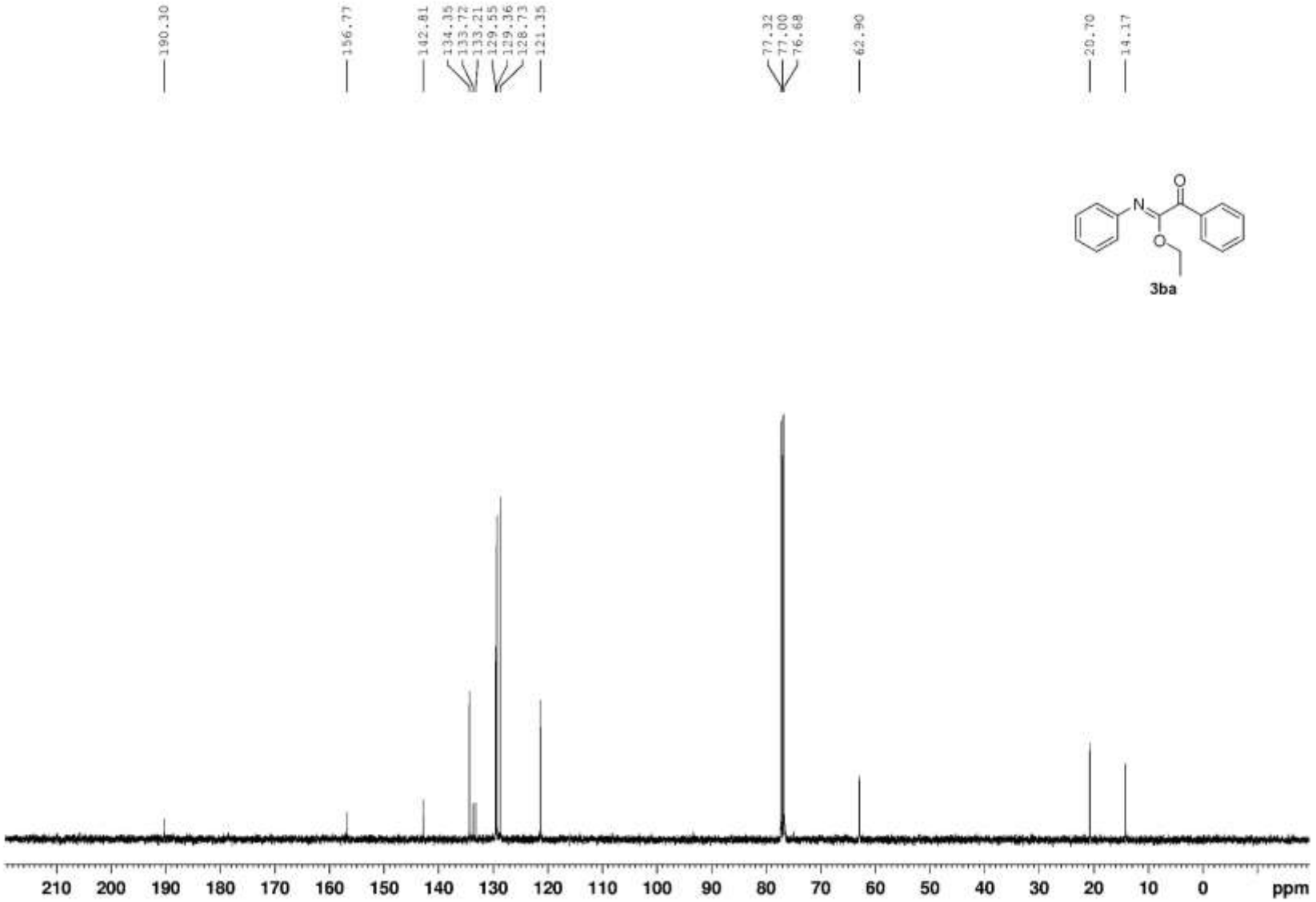
Yellow solid (m = 47 mg, 72%); m.p.: 140.1 – 144.9 $^{o}$C; **$^{1}$H NMR (400 MHz, $CDCl_3$)** δ: 8.08 – 8.05 (m, 2H), 7.61 (t, *J* = 7.4 Hz, 1H), 7.51 (t, *J* = 7.6 Hz, 2H), 7.30 – 7.26 (m, 2H ), 6.91 (d, *J* = 7.8 Hz, 2H), 6.85 (t, *J* = 7.3 Hz, 1H), 6.05 (d, *J* = 7.1 Hz, 1H), 5.37 (d, *J* = 7.3 Hz, 1H), 2.74 - 2.68 (m, 1H), 1.71 – 1.47 (m, 5H), 1.30 – 1.14 (m, 5H); **$^{13}$C NMR (101 MHz, $CDCl_3$)** δ: 190.99, 143.78, 134.30, 133.46, 129.22, 128.67, 128.61, 118.75, 114.38, 59.65, 41.00, 35.07, 34.45, 26.09, 25.40. HRMS (EI) $[M+H]^+$ m/z Calcd for $C_{20}H_{23}NOSH^+$ 326.1573, found 326.1575.

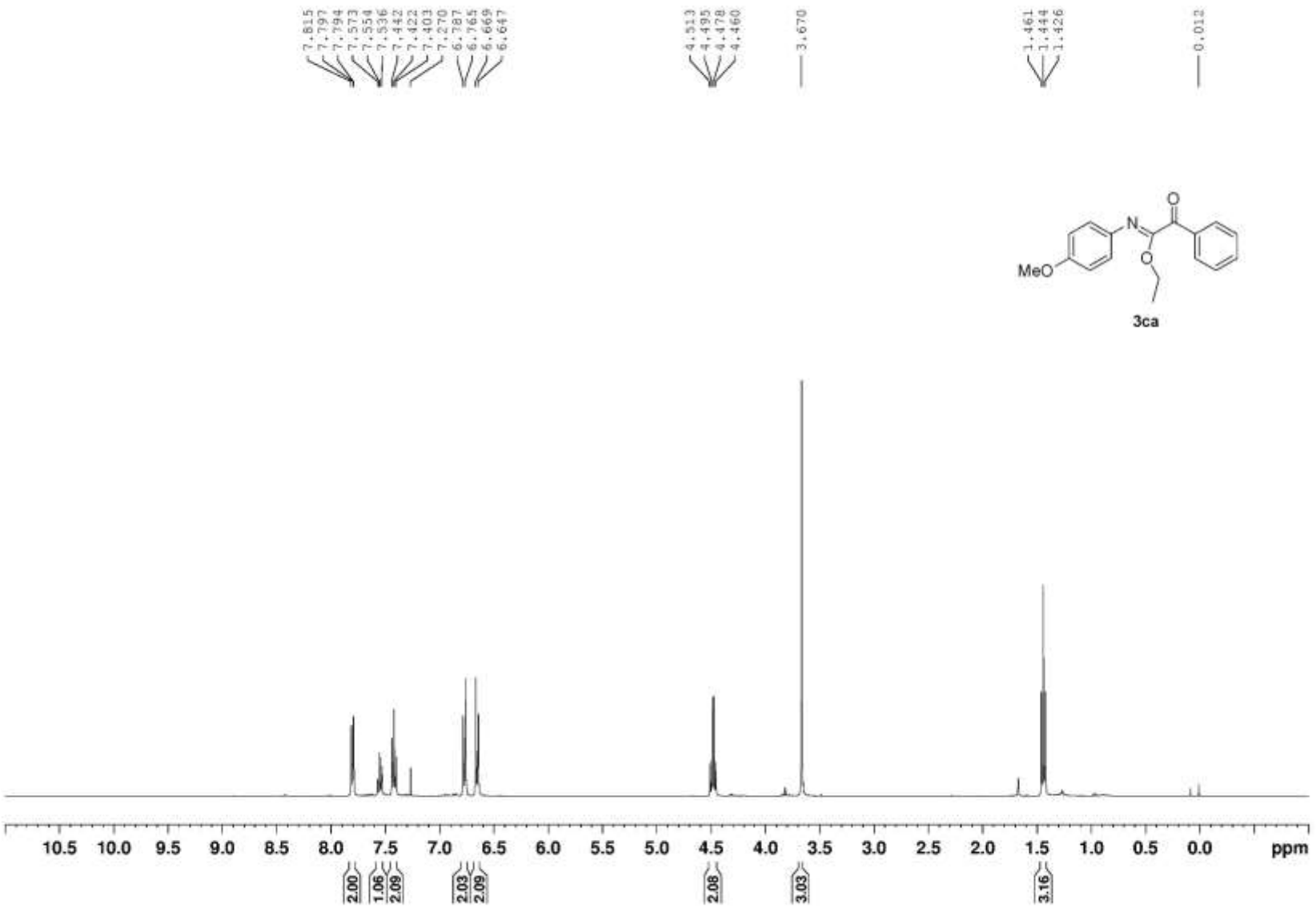
## *5.* Copies of $^{1}$H NMR and $^{13}$C NMR spectra

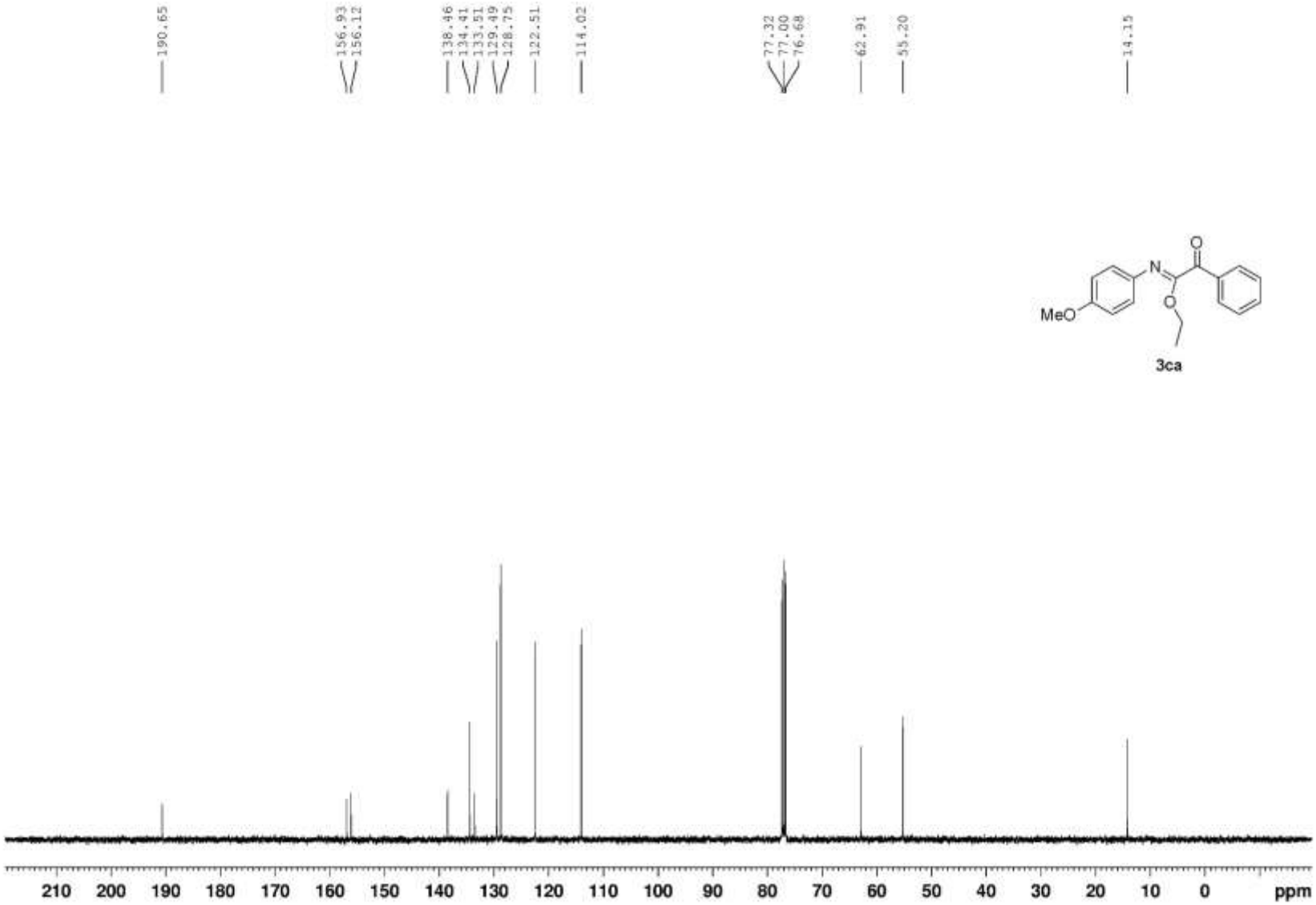

7.827
7.809
7.576
7.558
7.542
7.539
7.446
7.426
7.407
7.270
7.144
7.125
7.105
6.946
6.927
6.909
6.851
6.832
4.540
4.523
4.505
4.487
1.481
1.463
1.445
0.022
O
N
O
3aa
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
1.06
2.12
2.08
1.07
2.01
2.08
3.17

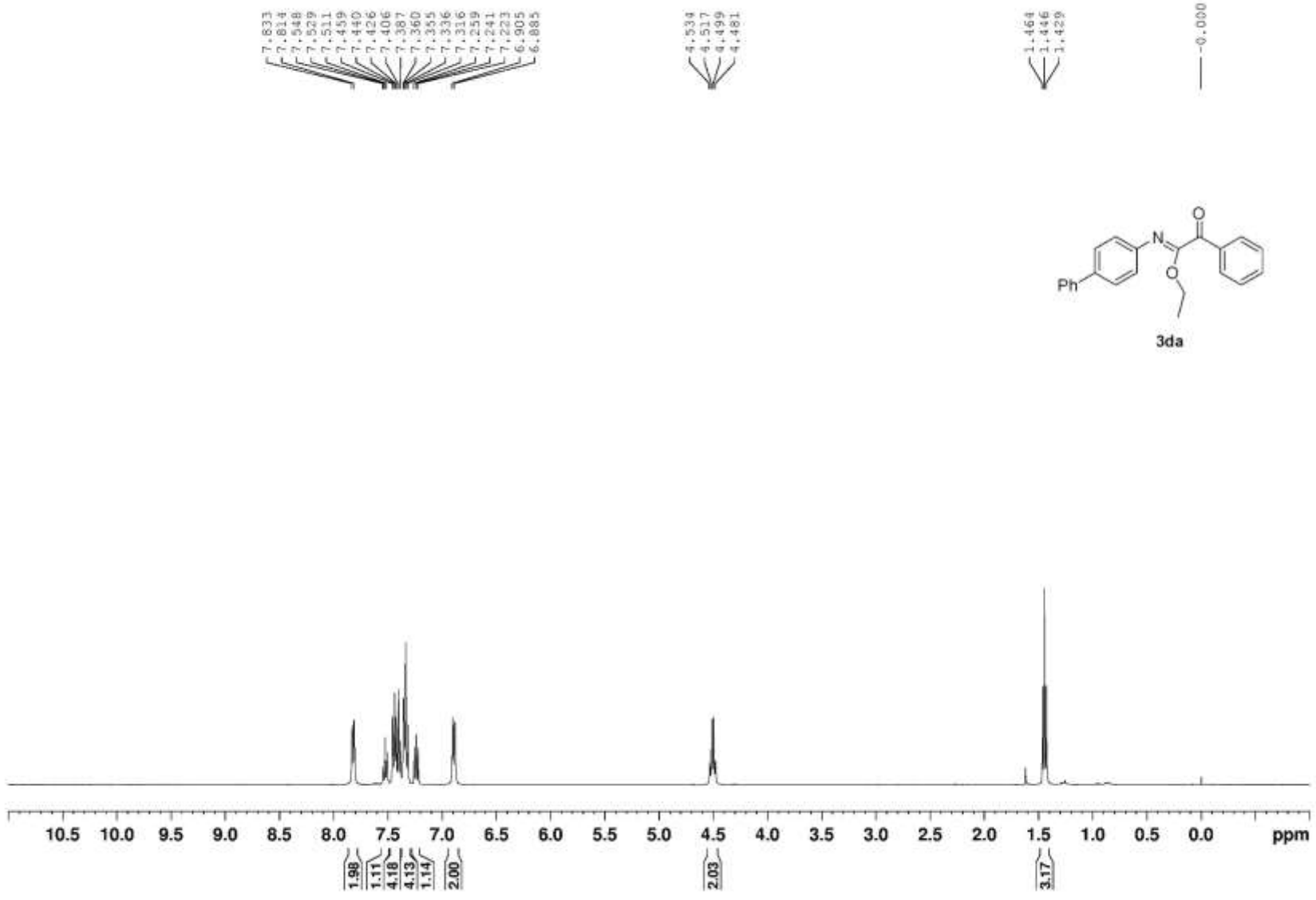

190.03
156.87
145.43
134.41
133.61
129.50
128.72
123.81
121.50
77.32
77.00
76.68
63.01
14.14
O
N
O
3aa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

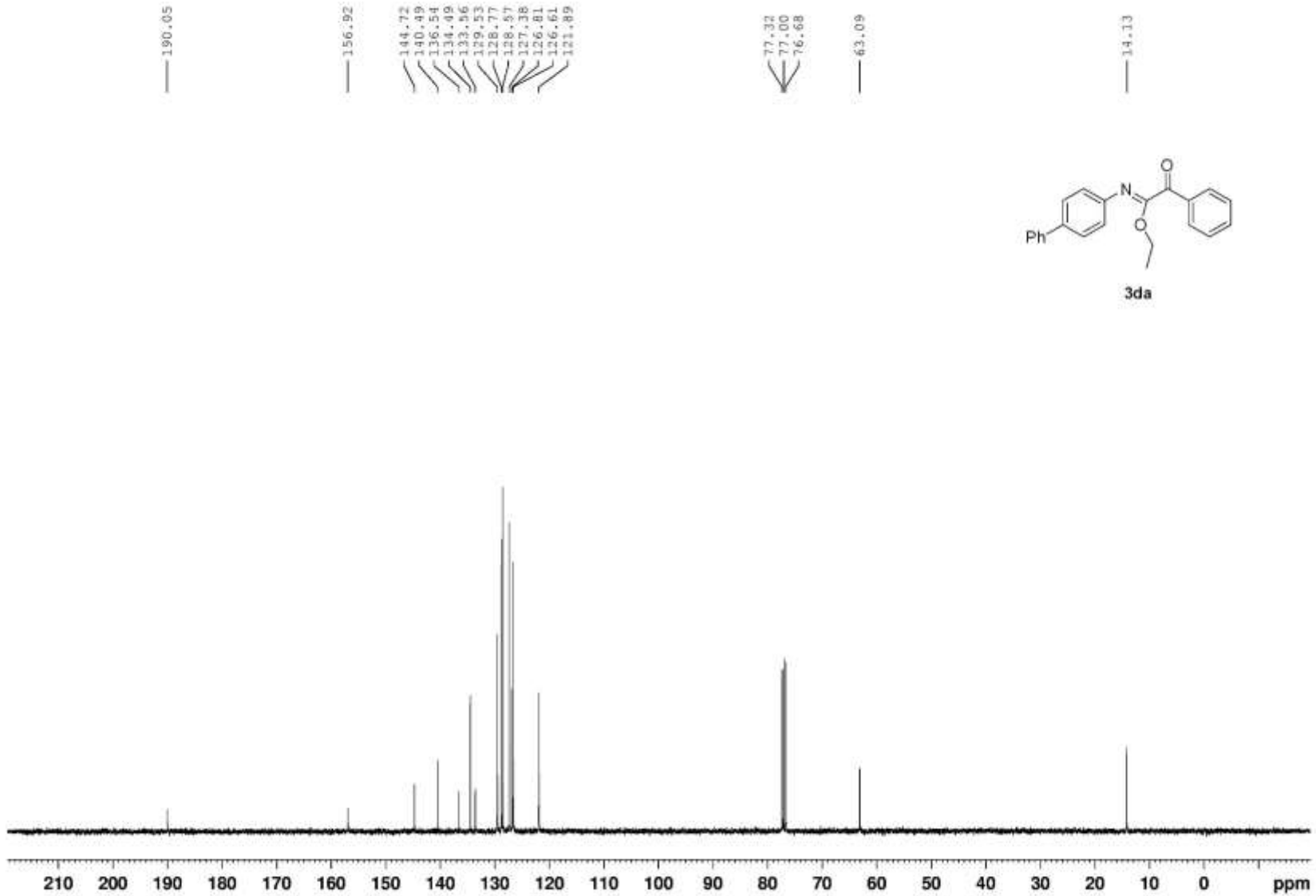

7.830
7.811
7.581
7.562
7.544
7.451
7.431
7.412
7.270
6.929
6.909
6.740
6.720
4.524
4.506
4.488
4.471
2.188
1.468
1.450
1.432
0.018
3ba
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.06
2.08
2.08
2.02
2.02
3.04
3.14

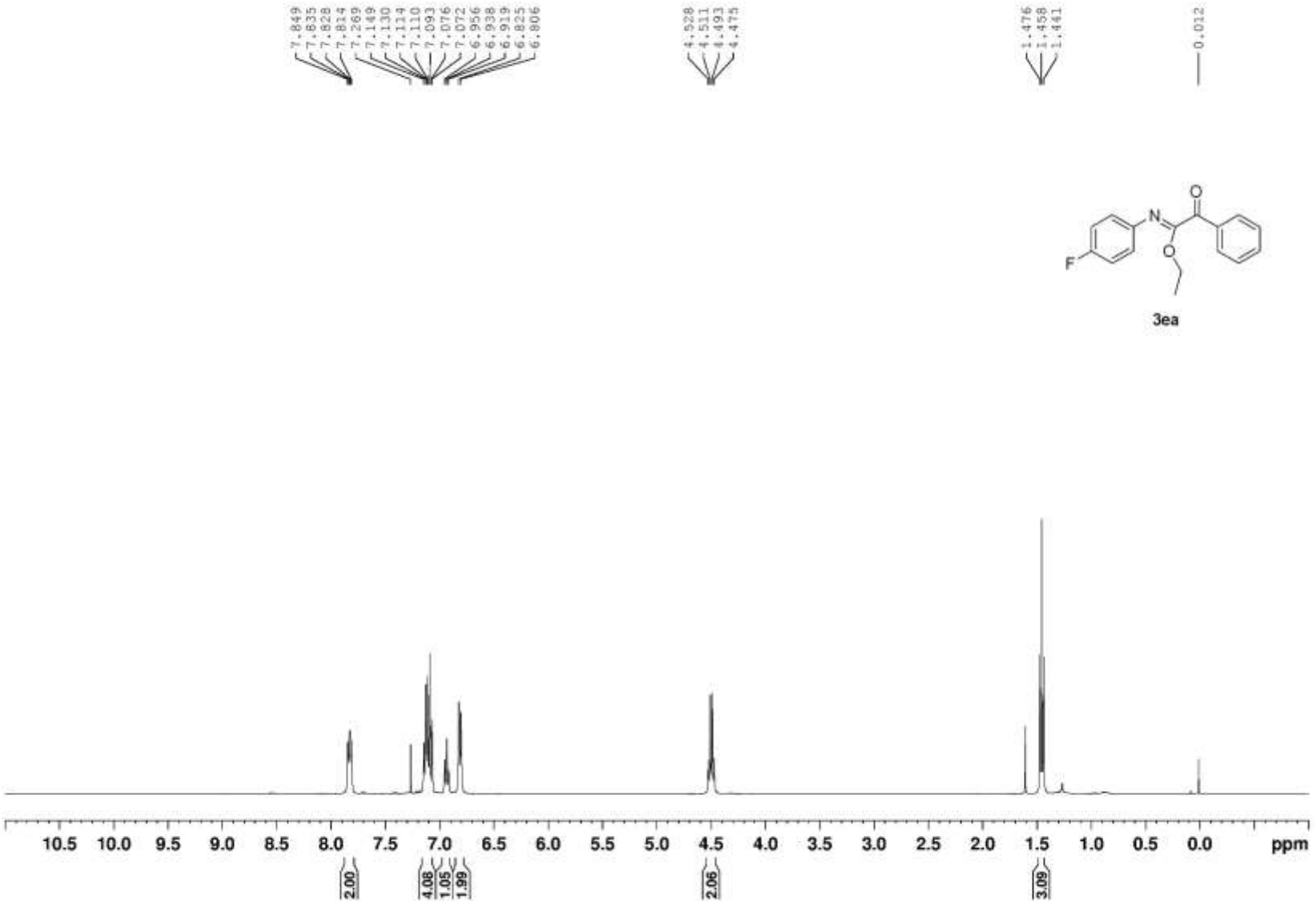

190.30
156.77
142.81
134.35
133.72
133.21
129.55
129.36
128.73
121.35
77.32
77.00
76.68
62.90
20.70
14.17
N
O
O
3ba
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

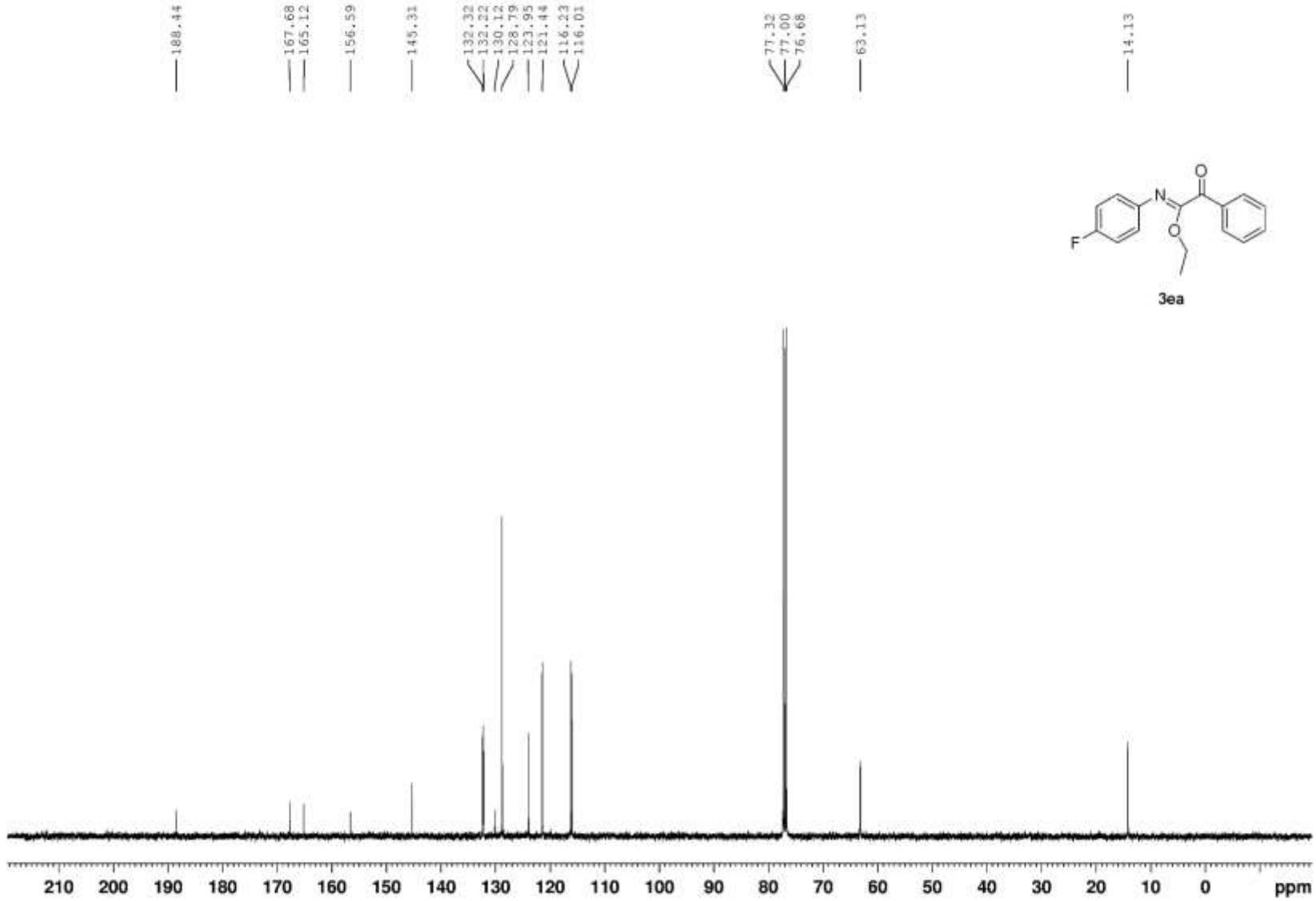

7.815
7.797
7.794
7.573
7.554
7.536
7.442
7.422
7.403
7.270
6.787
6.765
6.669
6.647
4.513
4.495
4.478
4.460
3.670
1.461
1.444
1.426
0.012
MeO
N
O
O
3ca
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.06
2.09
2.03
2.09
2.08
3.03
3.16

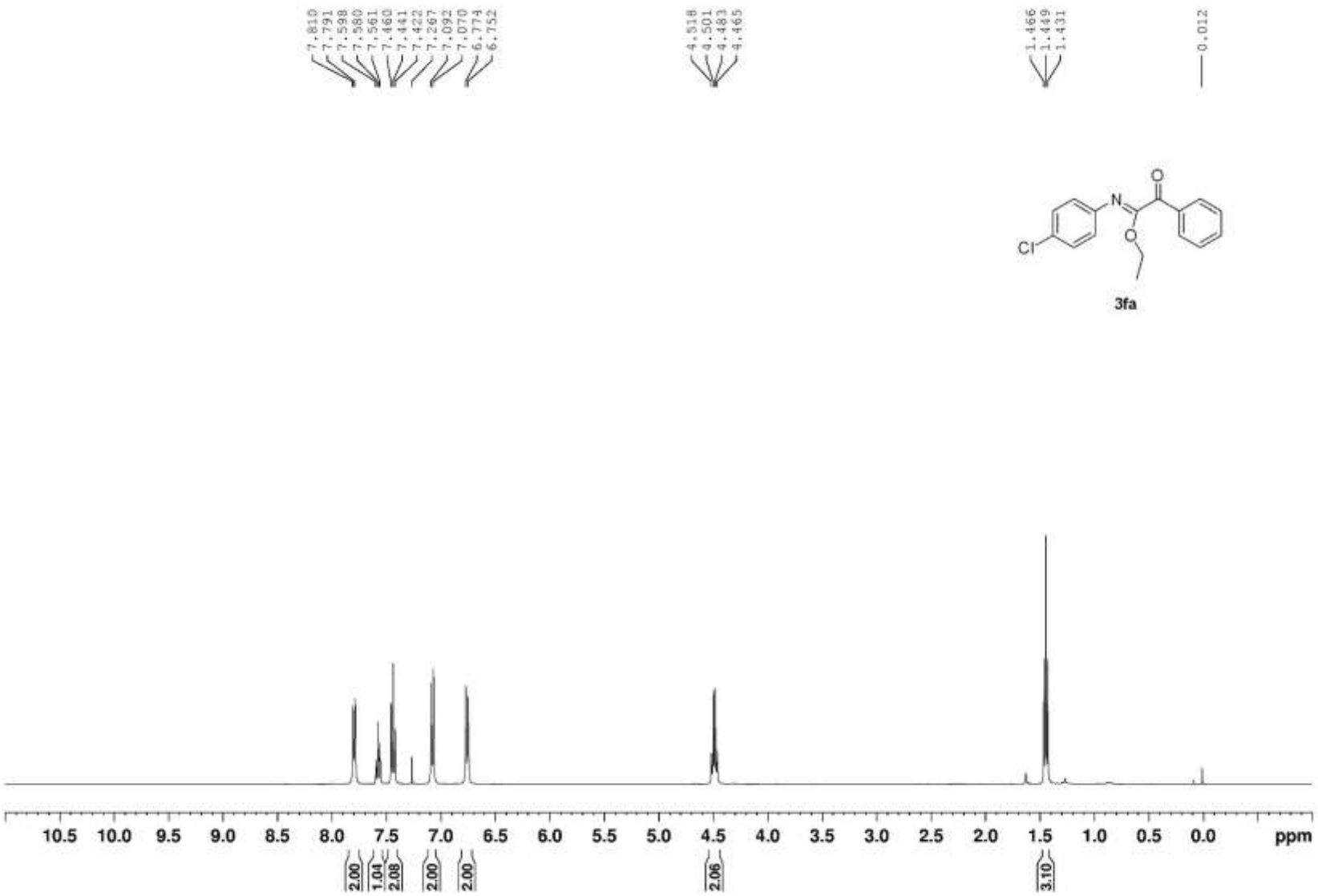

190.65
156.93
156.12
138.46
134.41
133.51
129.49
128.75
122.51
114.02
77.32
77.00
76.68
62.91
55.20
14.15
MeO
N
O
O
3ca
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

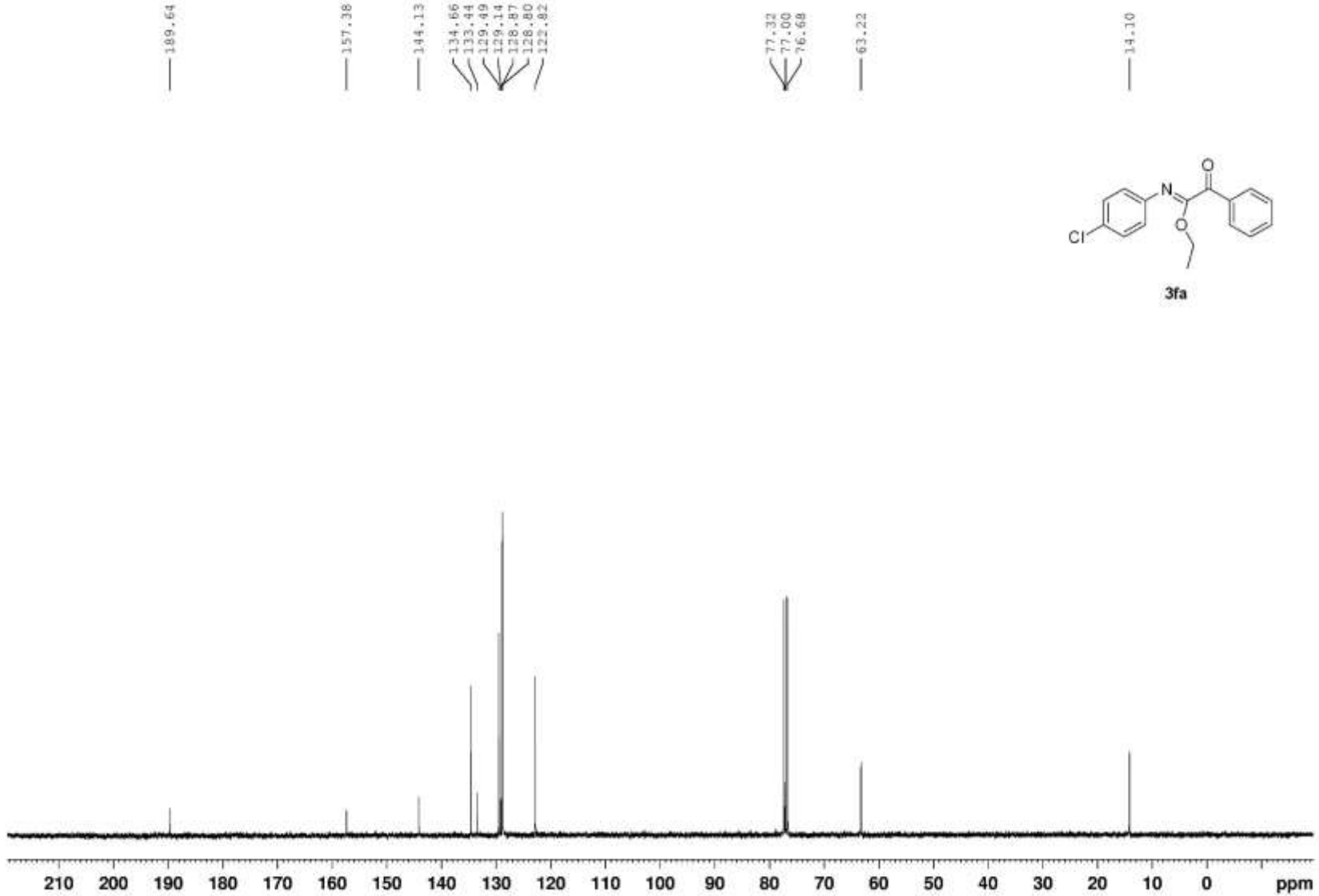

7.833
7.814
7.548
7.529
7.511
7.459
7.440
7.426
7.406
7.387
7.360
7.355
7.336
7.316
7.259
7.241
7.223
6.905
6.885
4.534
4.517
4.499
4.481
1.464
1.446
1.429
-0.000
N
O
O
Ph
3da
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.90
1.11
4.18
4.13
1.14
2.00
2.03
3.17

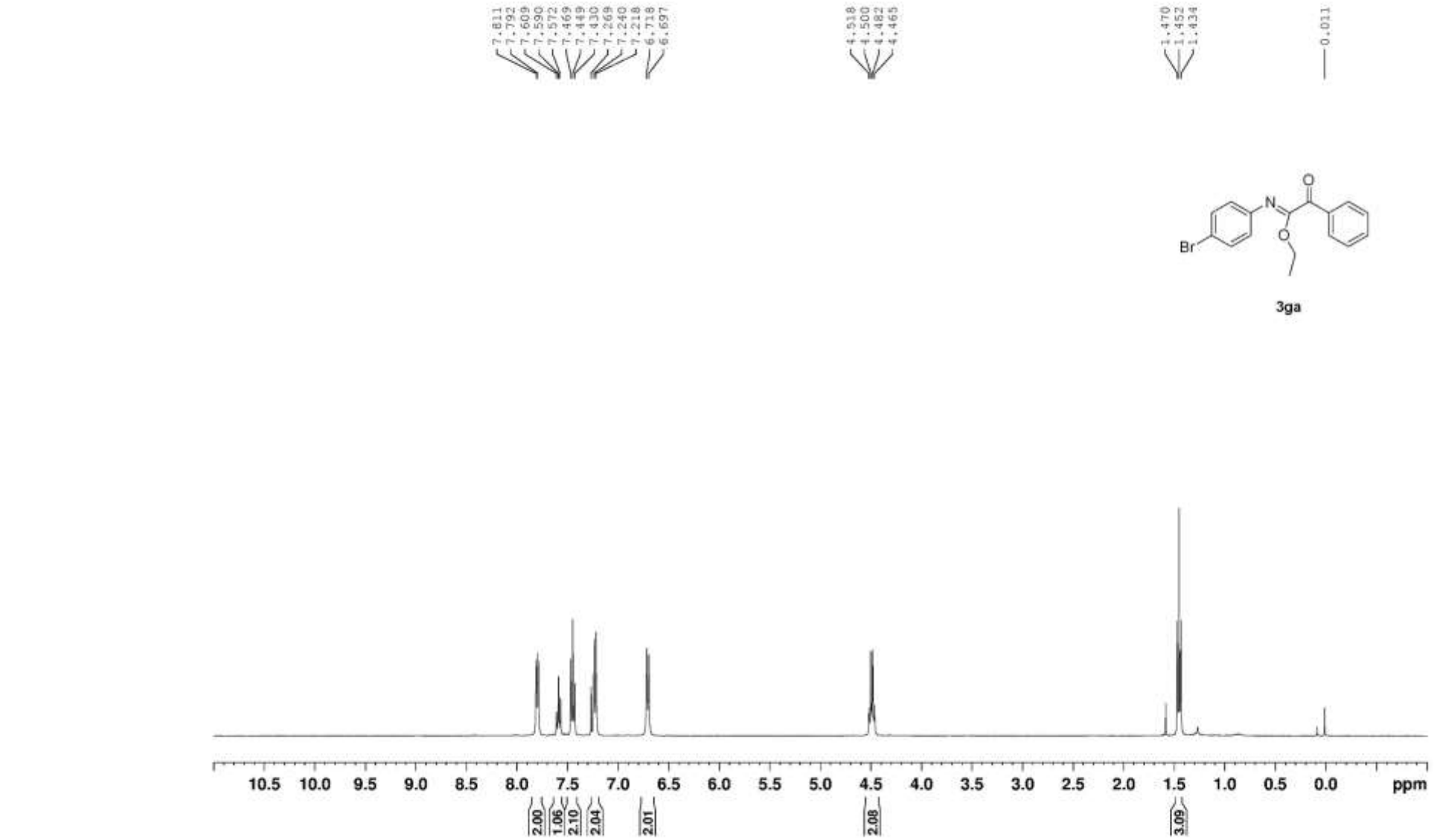

190.05
156.92
144.72
140.49
136.54
134.49
133.56
129.53
128.77
128.57
127.38
126.81
126.61
121.89
77.32
77.00
76.68
63.09
14.13
Ph
N
O
O
3da
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

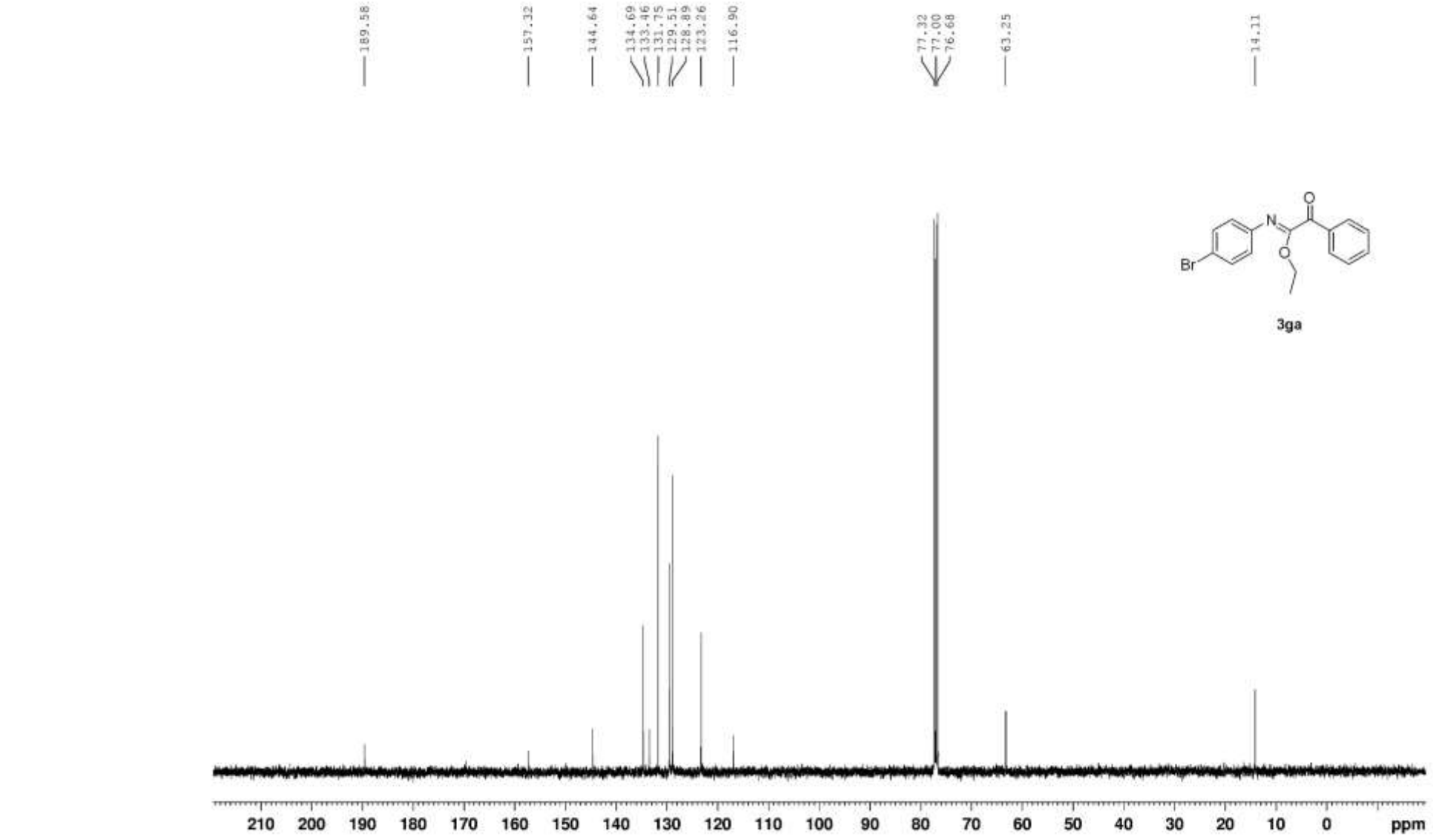

7.849
7.835
7.828
7.814
7.269
7.149
7.130
7.114
7.110
7.093
7.076
7.072
6.956
6.938
6.919
6.825
6.806
4.528
4.511
4.493
4.475
1.476
1.458
1.441
0.012
N
O
O
F
3ea
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
4.08
1.05
1.99
2.06
3.09

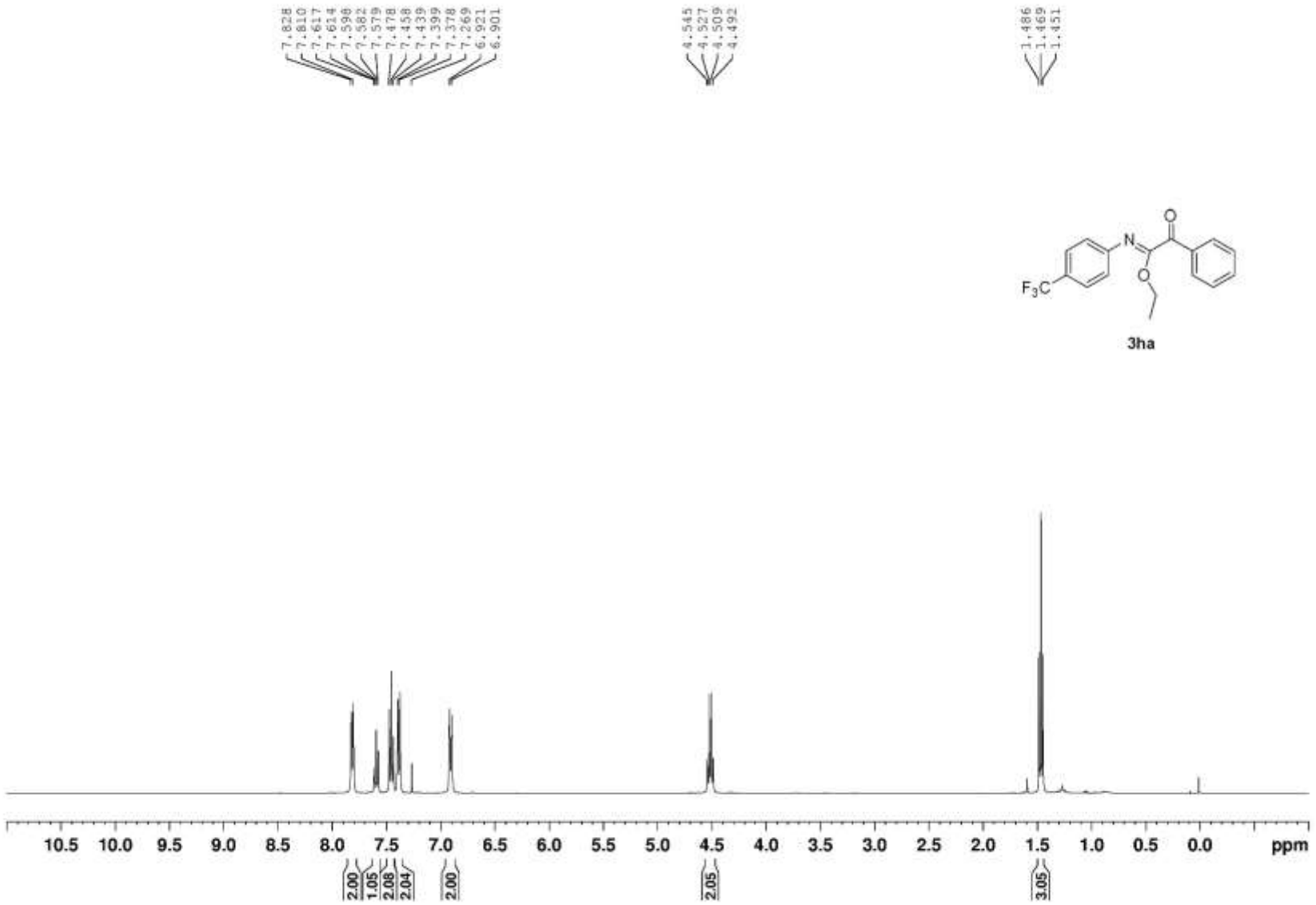

188.44
167.68
165.12
156.59
145.31
132.32
132.22
130.12
128.79
123.95
121.44
116.23
116.01
77.32
77.00
76.68
63.13
14.13
F
N
O
O
3ea
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm


7.810
7.791
7.598
7.580
7.561
7.460
7.441
7.422
7.267
7.092
7.070
6.774
6.752
4.518
4.501
4.483
4.465
1.466
1.449
1.431
0.012
Cl
N
O
O
3fa
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.04
2.08
2.00
2.00
2.06
3.10

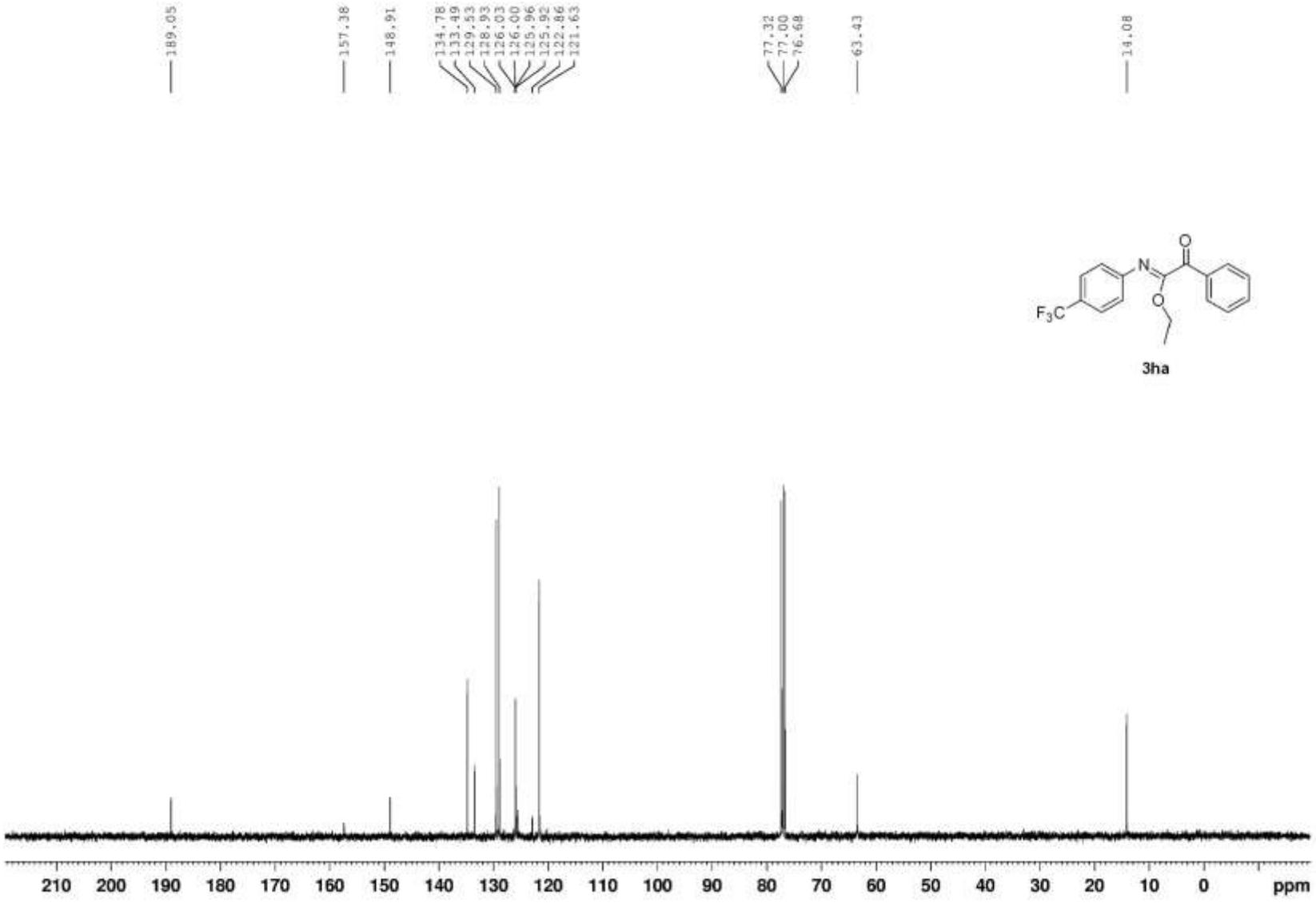

189.64
157.38
144.13
134.66
133.44
129.49
129.14
128.87
128.80
122.82
77.32
77.00
76.68
63.22
14.10
Cl
N
O
O
3fa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

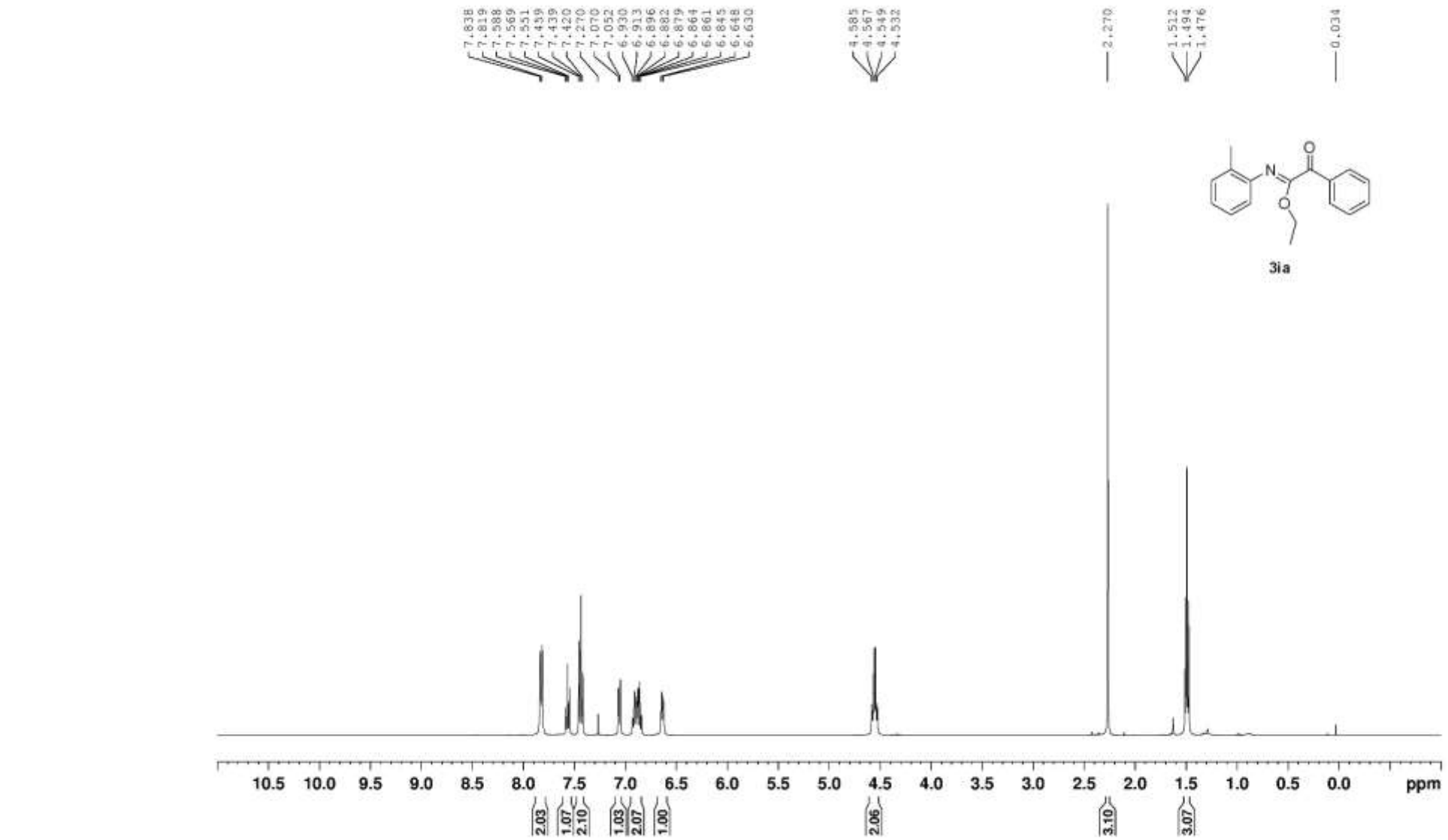

7.811
7.792
7.609
7.590
7.572
7.469
7.449
7.430
7.269
7.240
7.218
6.718
6.697
4.518
4.500
4.482
4.465
1.470
1.452
1.434
0.011
O
N
O
Br
3ga
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.06
2.10
2.04
2.01
2.08
3.09

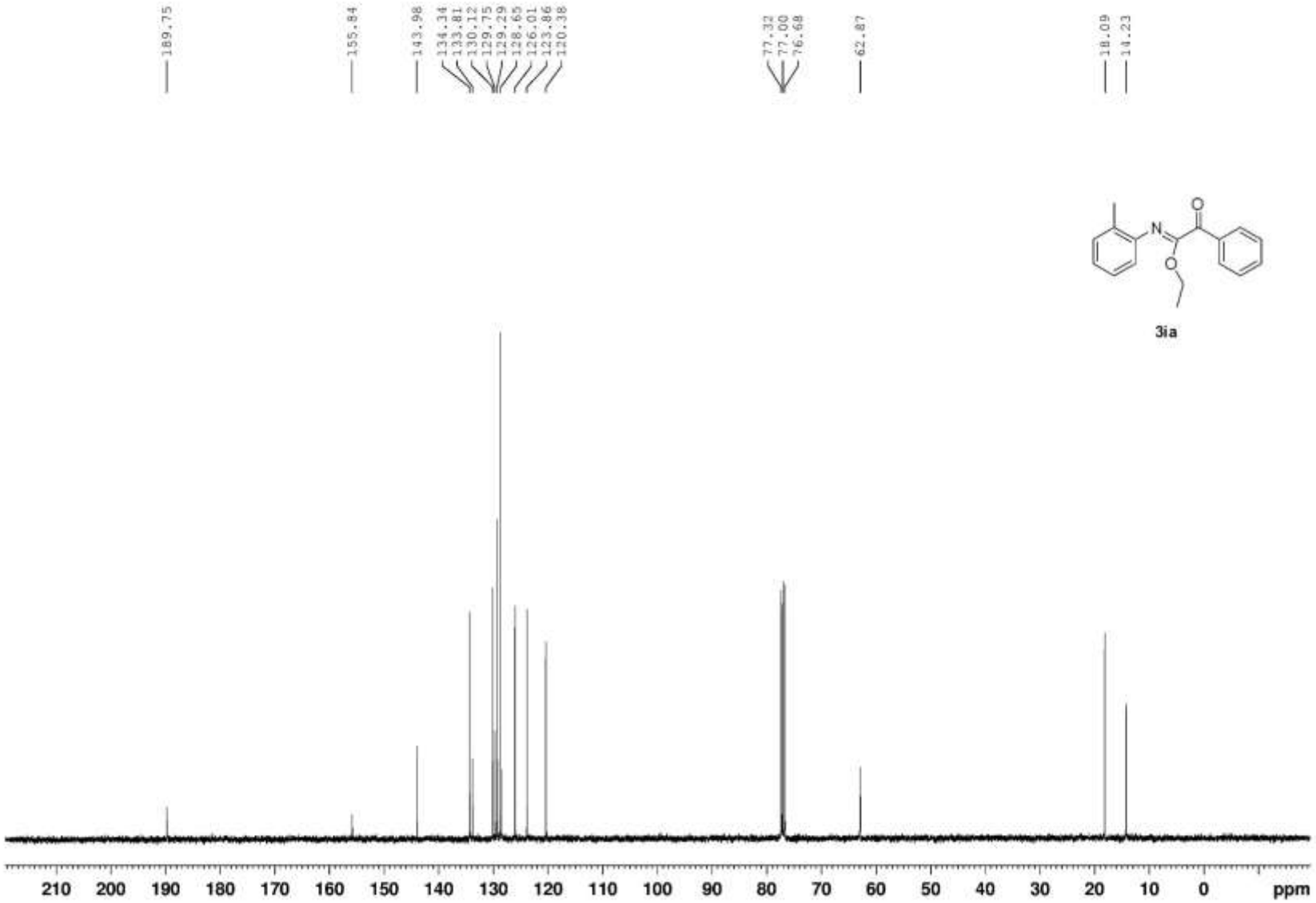

189.58
157.32
144.64
134.69
133.46
131.75
129.51
128.89
123.26
116.90
77.32
77.00
76.68
63.25
14.11
Br
N
O
O
3ga
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

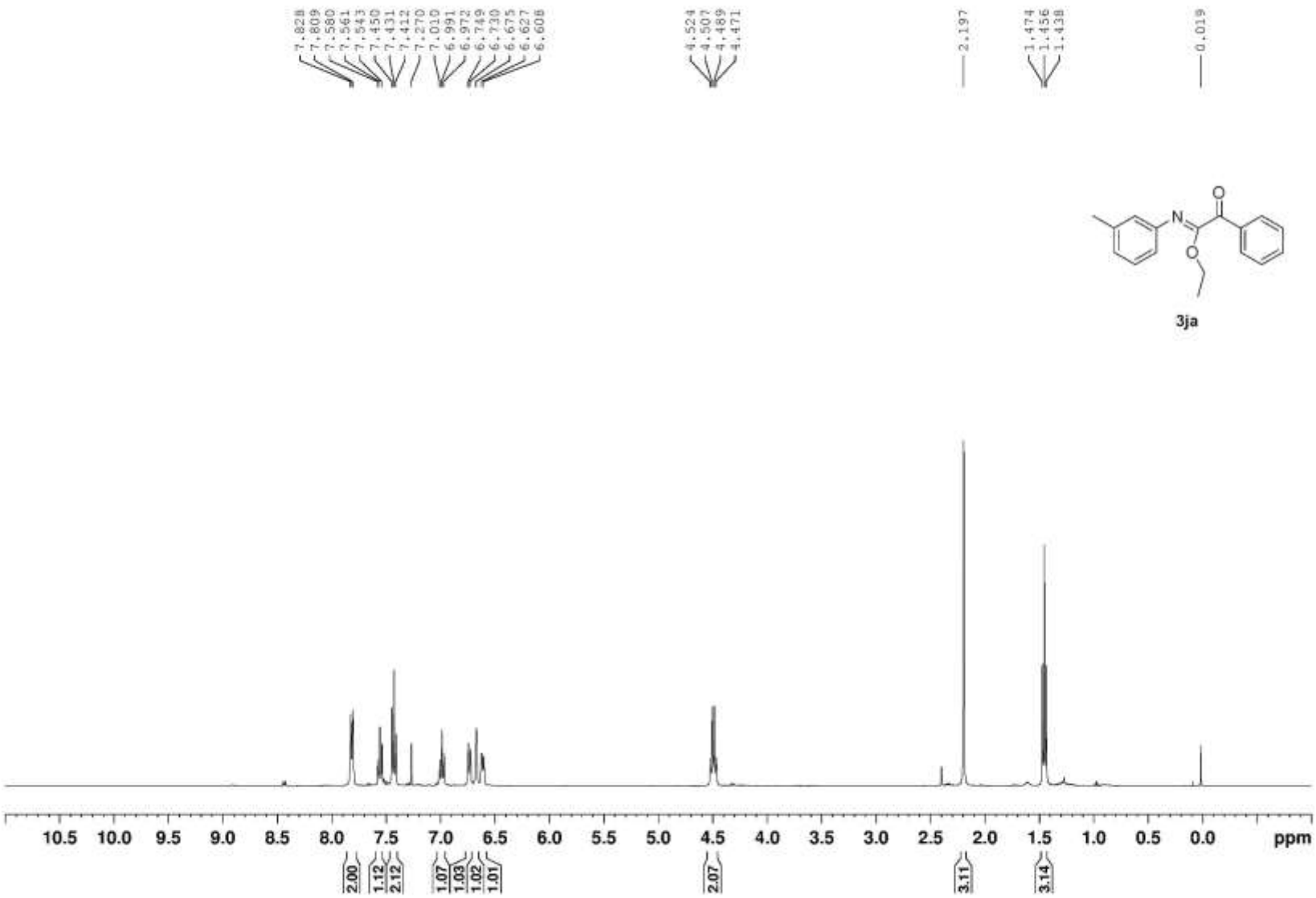

7.828
7.810
7.617
7.614
7.596
7.582
7.579
7.478
7.458
7.439
7.399
7.378
7.269
6.921
6.901
4.545
4.527
4.509
4.492
1.486
1.469
1.451
N
O
O
F3C
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
1.05
2.08
2.04
2.00
2.05
3.05

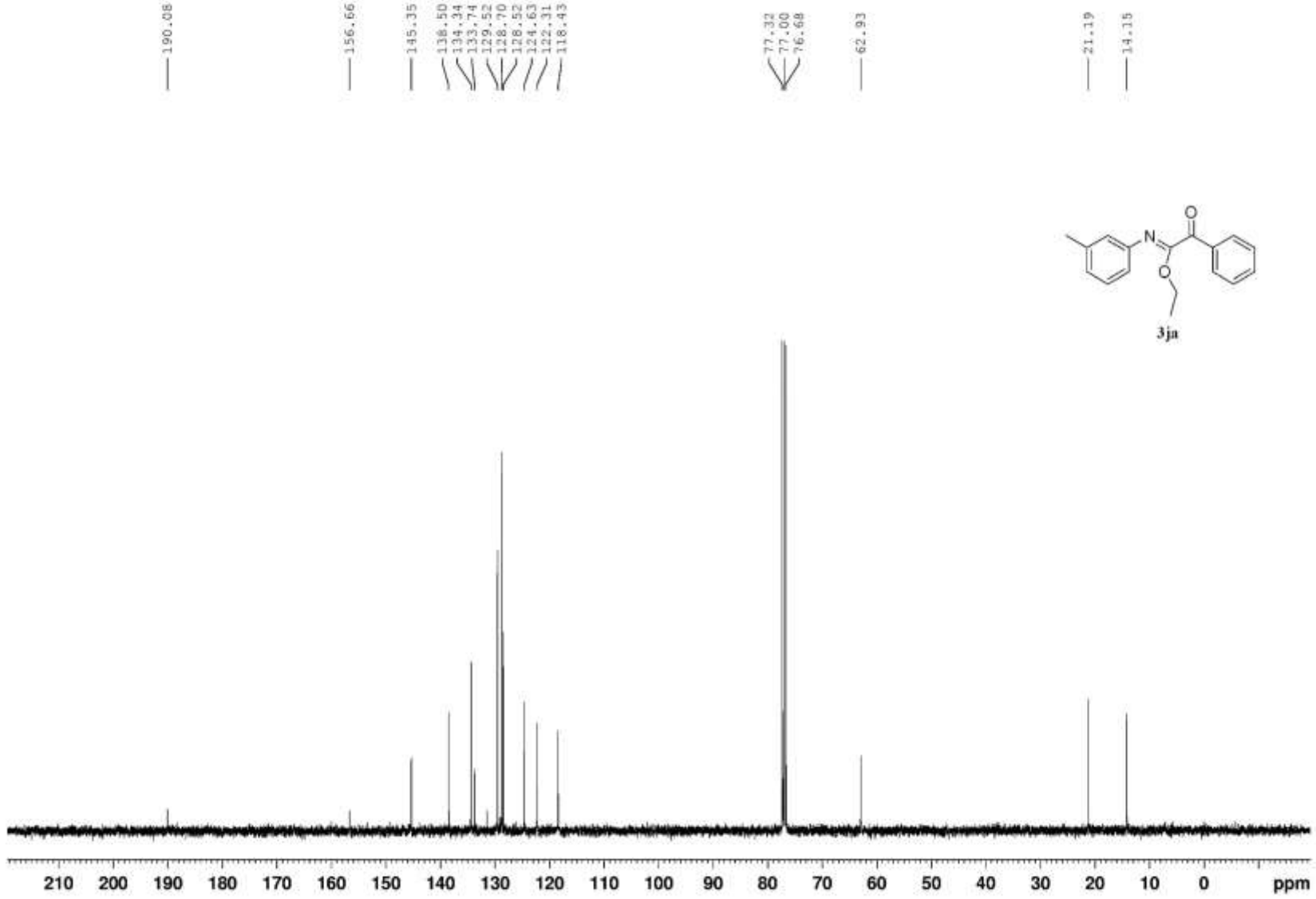
3ha

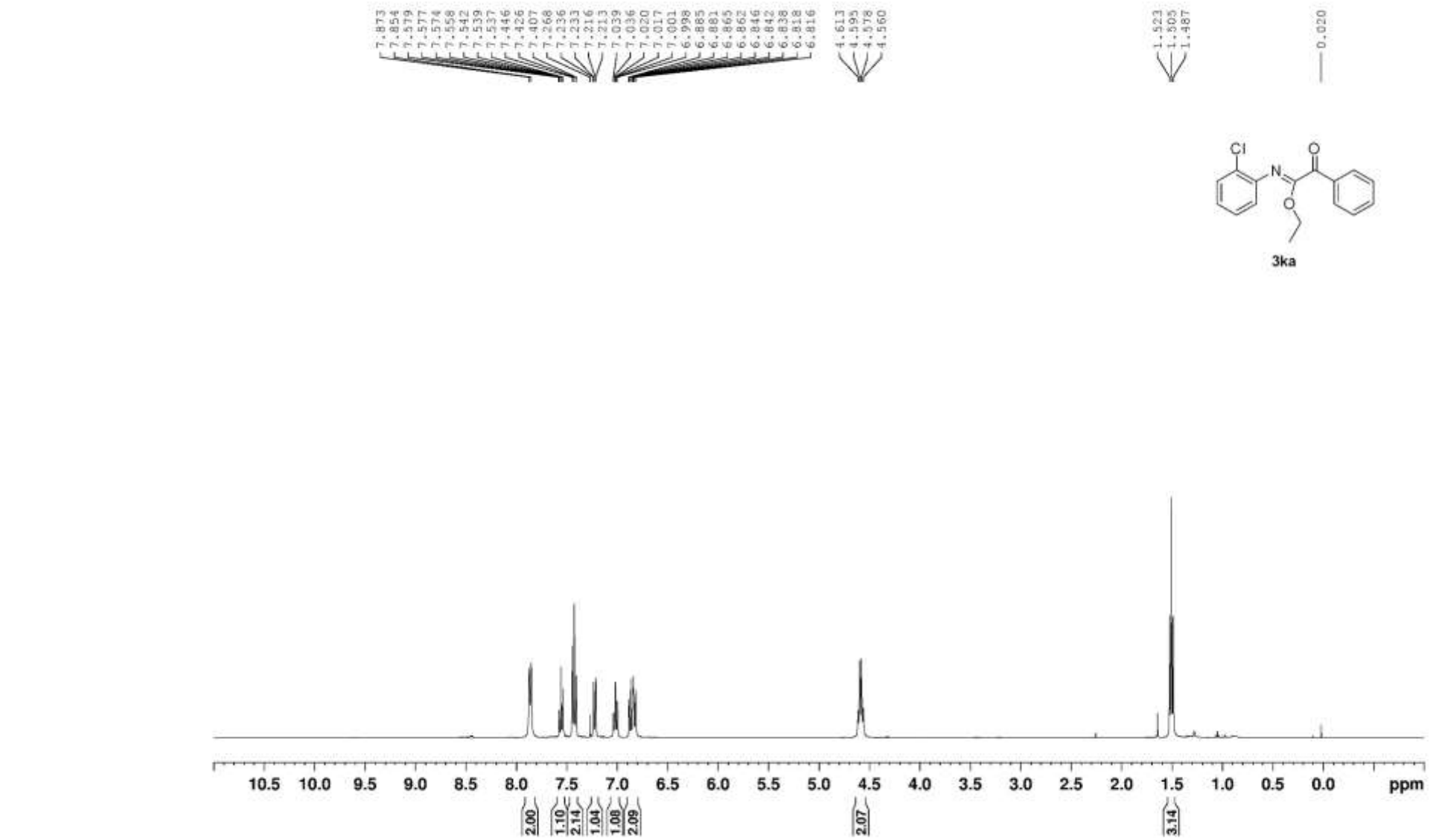

189.05
157.38
148.91
134.78
133.49
129.53
128.93
126.03
126.00
125.96
125.92
122.86
121.63
77.32
77.00
76.68
63.43
14.08
O
N
O
F3C
3ha
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

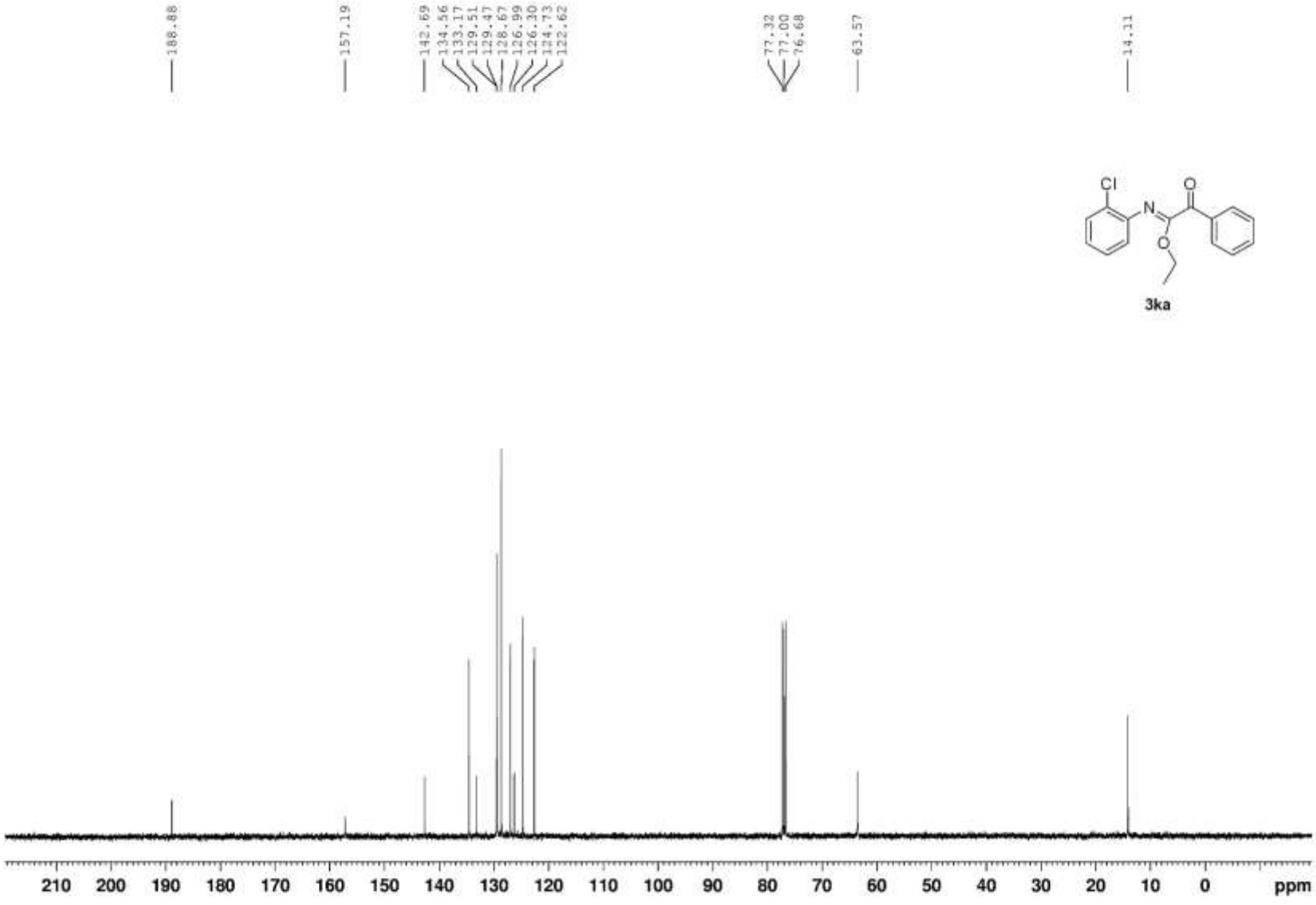

7.838
7.819
7.588
7.569
7.551
7.439
7.439
7.420
7.270
7.070
7.052
6.930
6.913
6.896
6.882
6.879
6.864
6.861
6.845
6.648
6.630
4.585
4.567
4.549
4.532
2.270
1.512
1.494
1.476
0.034
3ia
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.03
1.07
2.10
1.03
2.07
1.00
2.06
3.10
3.07

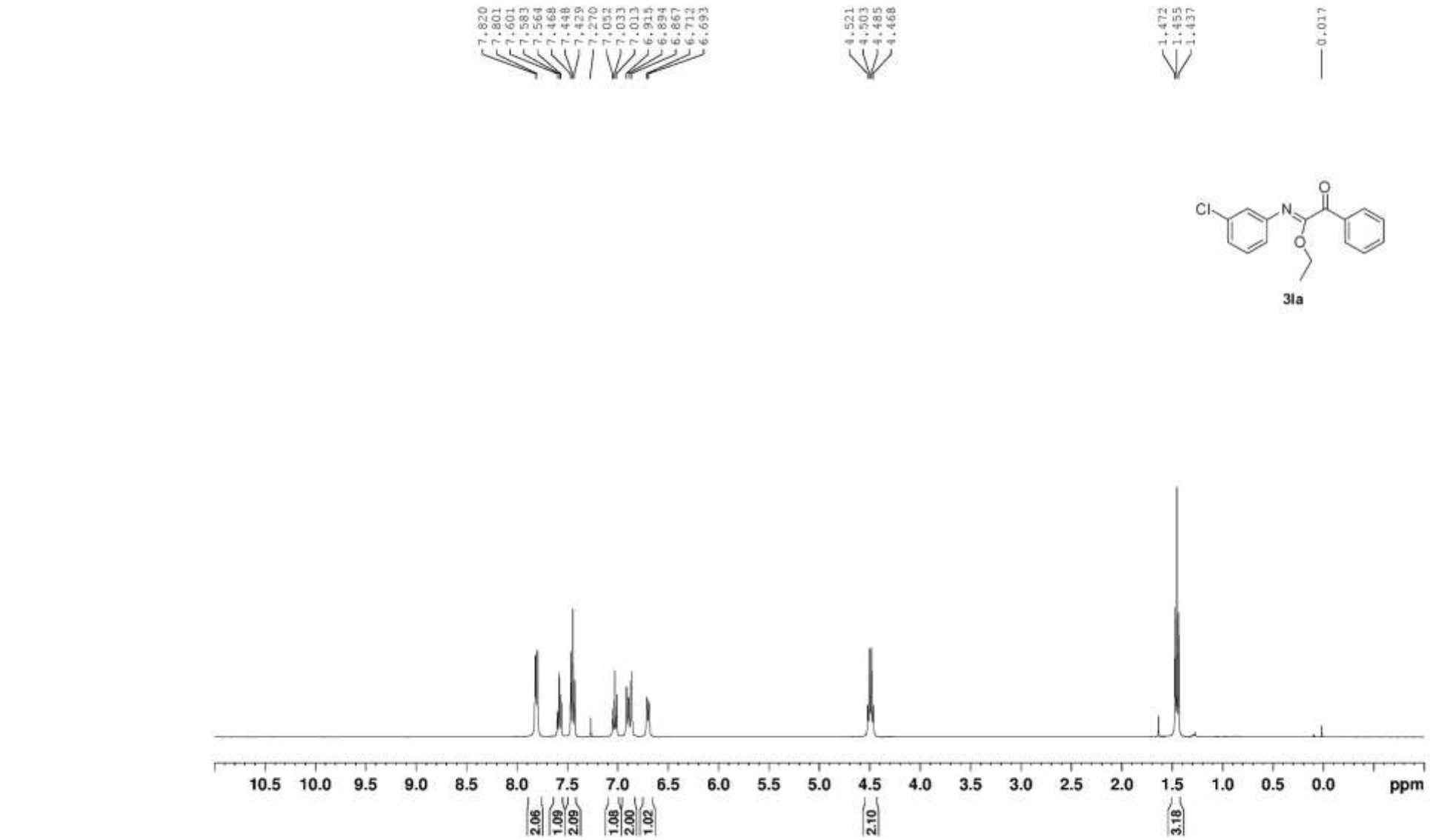

189.75
155.84
143.98
134.34
133.81
130.12
129.75
129.29
128.65
126.01
123.86
120.38
77.32
77.00
76.68
62.87
18.09
14.23
N
O
O
3ia
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

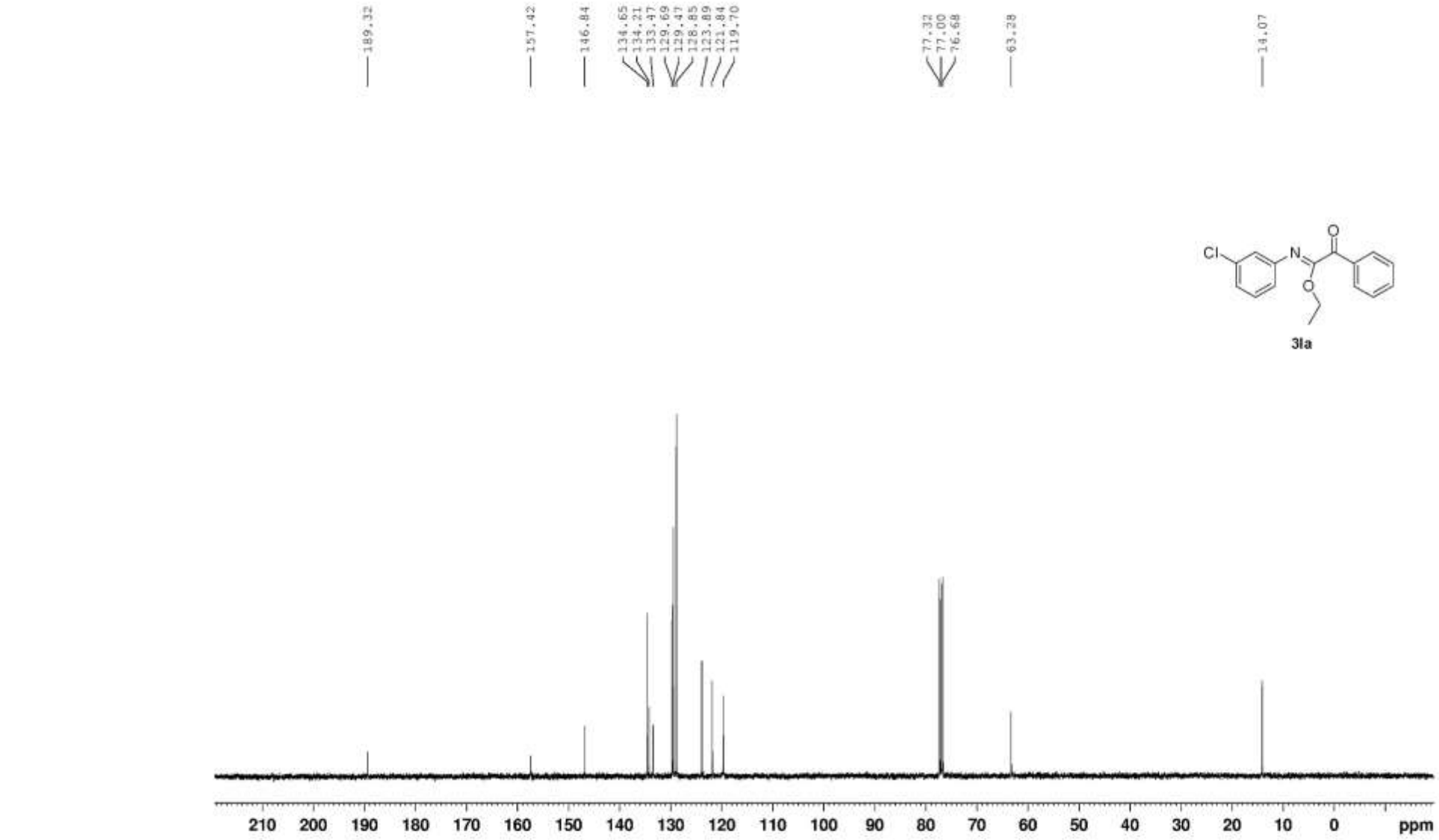

7.828
7.809
7.580
7.561
7.543
7.450
7.431
7.412
7.270
7.010
6.991
6.972
6.749
6.730
6.675
6.627
6.608
4.524
4.507
4.489
4.471
2.197
1.474
1.456
1.438
0.019
N
O
O
3ja
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.12
2.12
1.07
1.03
1.02
1.01
2.07
3.11
3.14

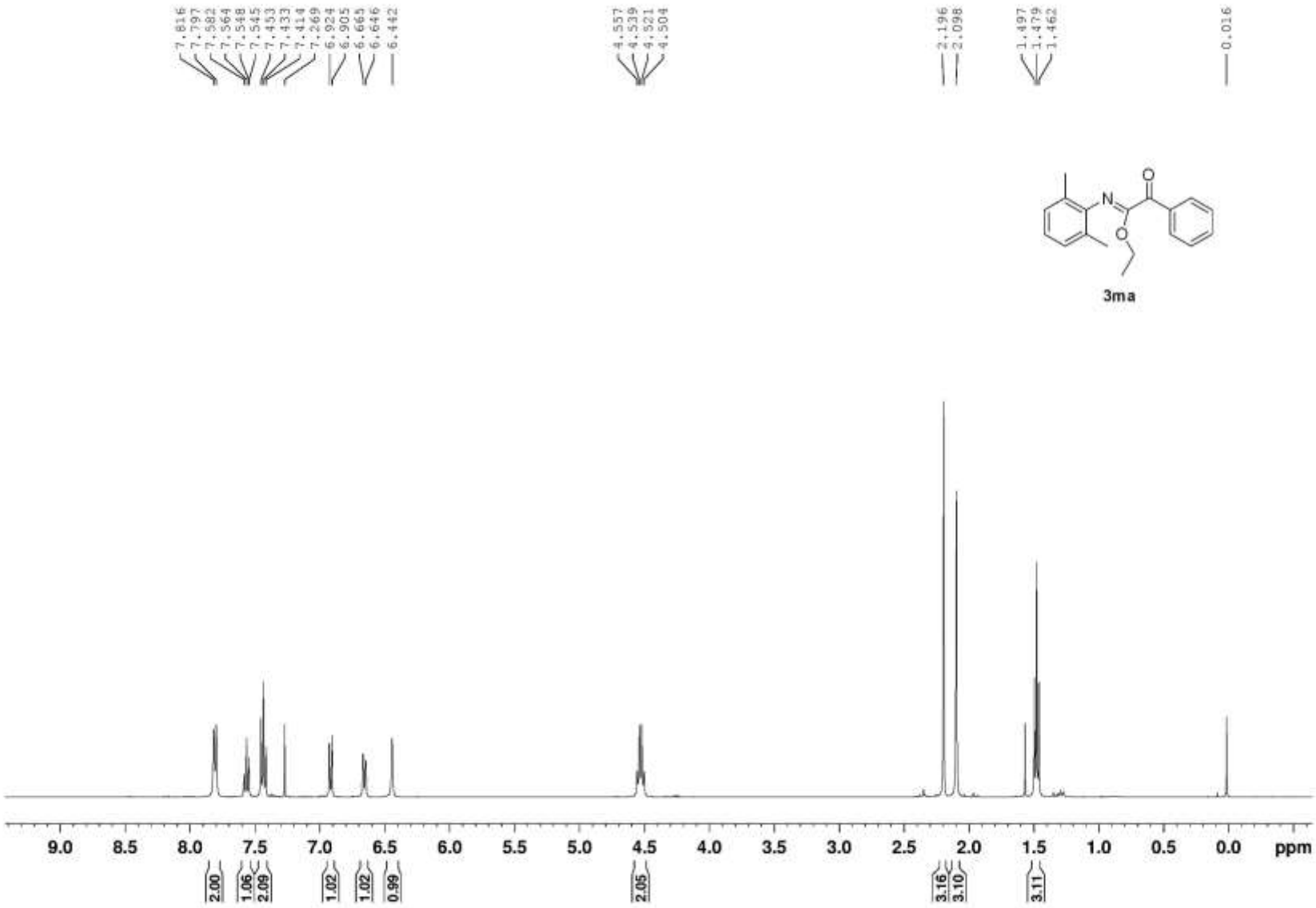

190.08
156.66
145.35
138.50
134.34
133.74
129.52
128.70
128.52
124.63
122.31
118.43
77.32
77.00
76.68
62.93
21.19
14.15
O
N
O
3ja
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

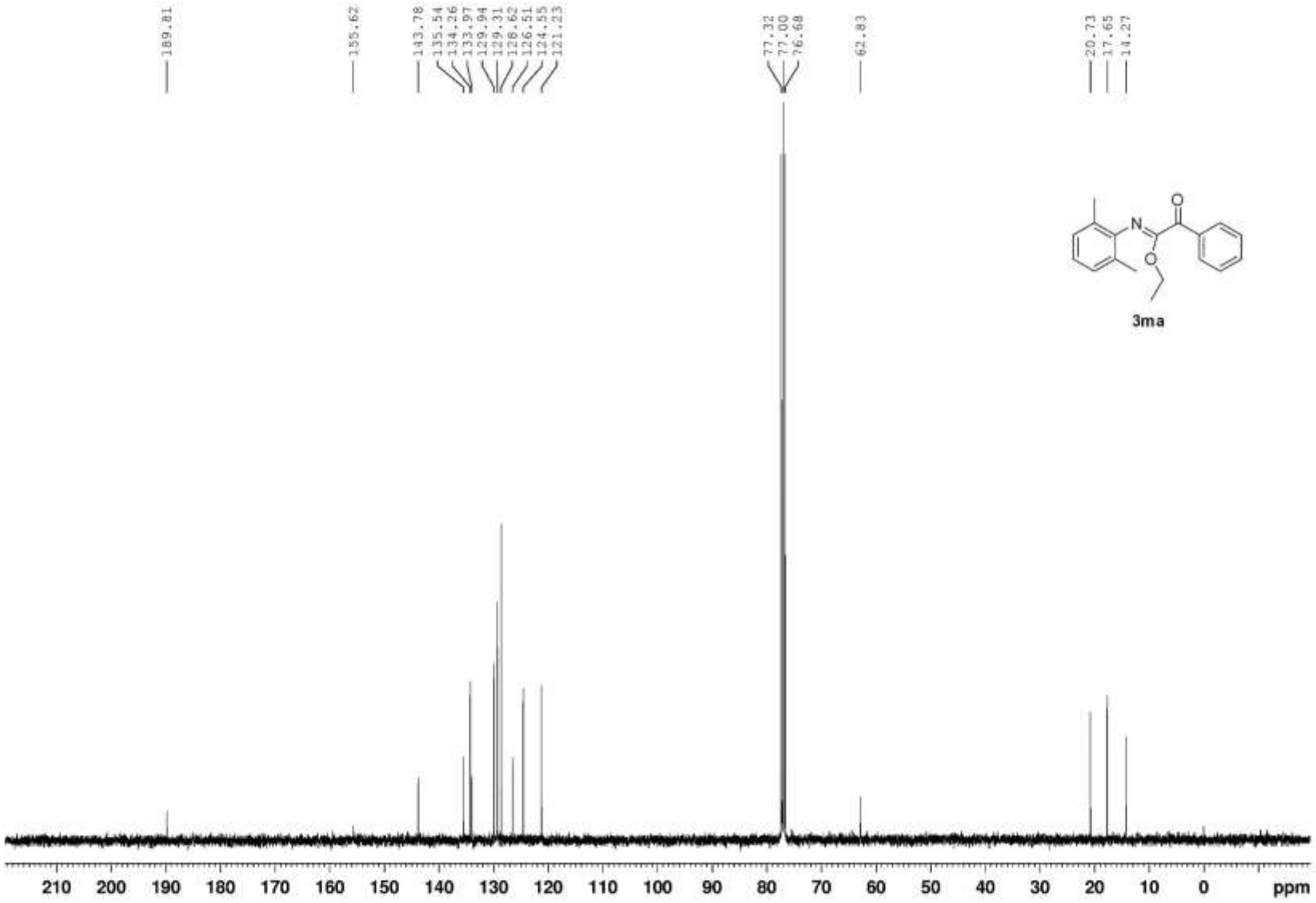

7.873
7.854
7.579
7.577
7.574
7.558
7.542
7.539
7.537
7.446
7.426
7.407
7.268
7.236
7.233
7.216
7.213
7.039
7.036
7.020
7.017
7.001
6.998
6.885
6.881
6.865
6.862
6.846
6.842
6.838
6.818
6.816
4.613
4.595
4.578
4.560
1.523
1.505
1.487
0.020
Cl
N
O
O
3ka
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
1.10
2.14
1.04
1.06
2.09
2.07
3.14

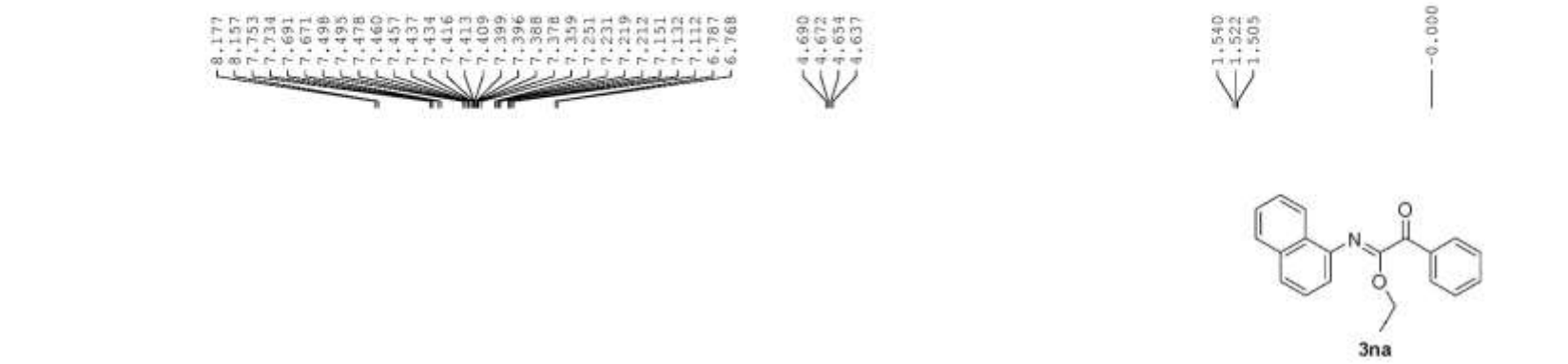

188.88
157.19
142.69
134.56
133.17
129.51
129.47
128.67
126.99
126.30
124.73
122.62
77.32
77.00
76.68
63.57
14.11
Cl
N
O
O
3ka
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

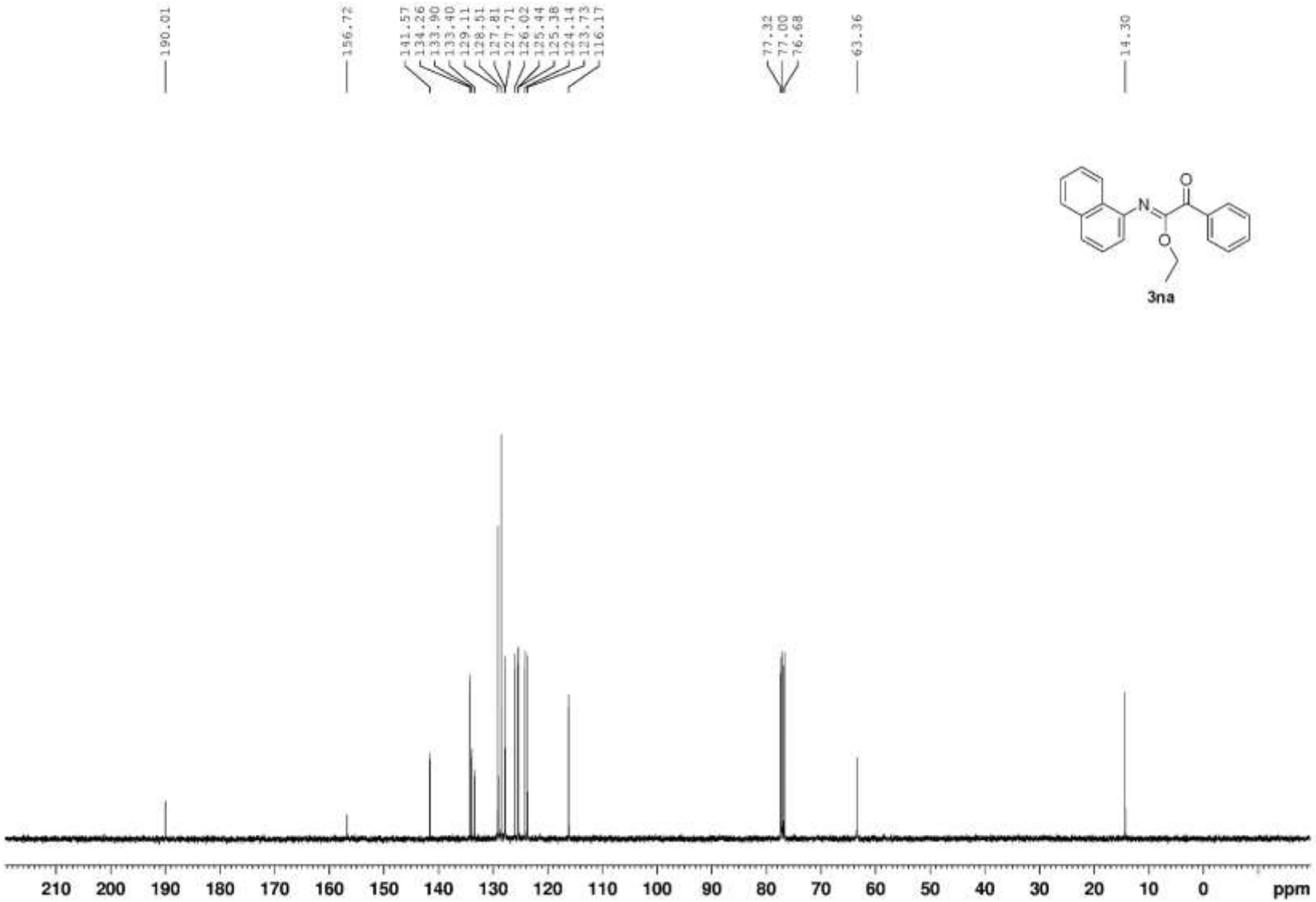

7.820
7.801
7.601
7.583
7.564
7.468
7.448
7.429
7.270
7.052
7.033
7.013
6.915
6.894
6.867
6.712
6.693
4.521
4.503
4.485
4.468
1.472
1.455
1.437
0.017
Cl
N
O
O
3la
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.06
1.09
2.09
1.08
2.00
1.02
2.10
3.18

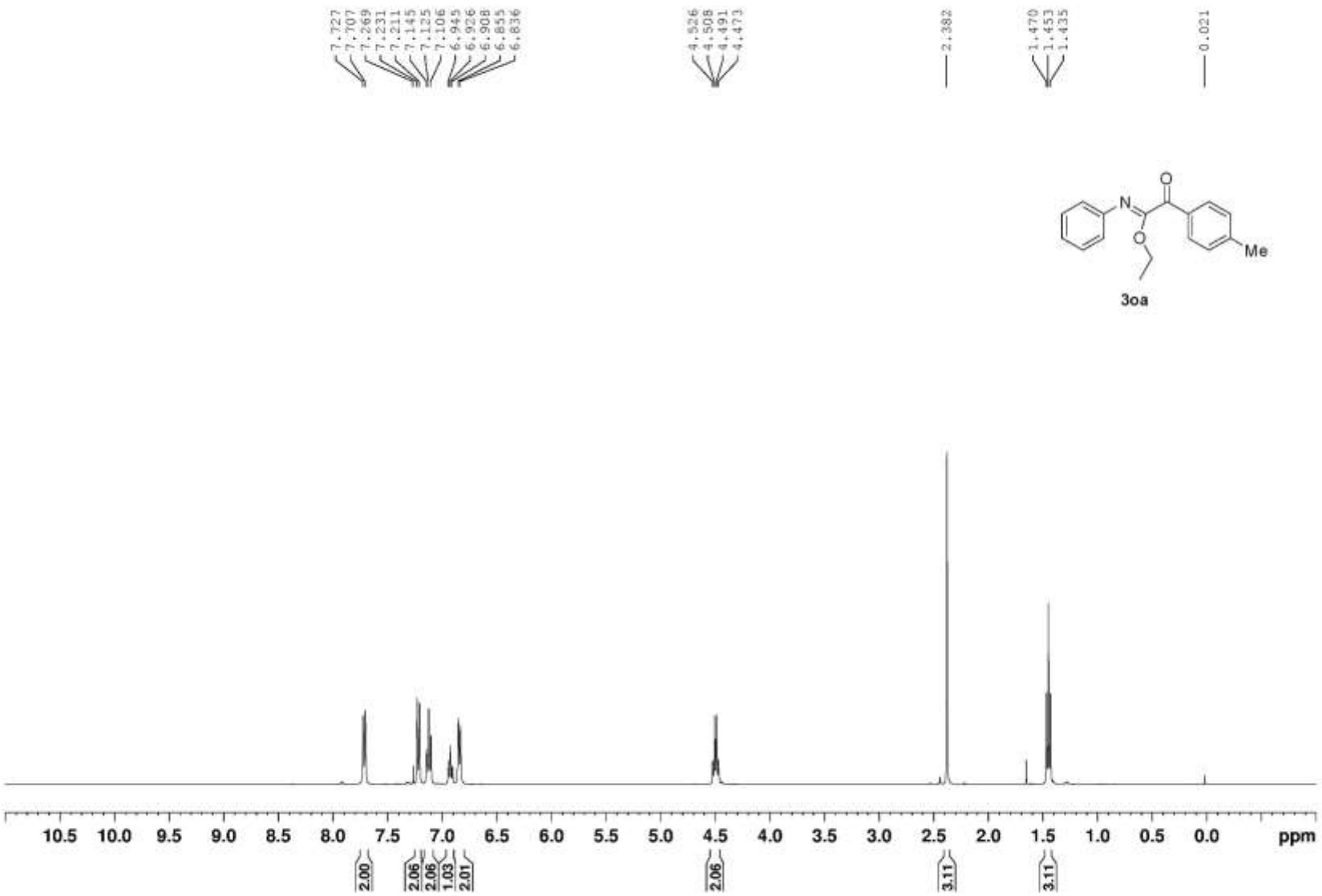

189.32
157.42
146.84
134.65
134.21
133.47
129.69
129.47
128.85
123.89
121.84
119.70
77.32
77.00
76.68
63.28
14.07
Cl
N
O
O
3la
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

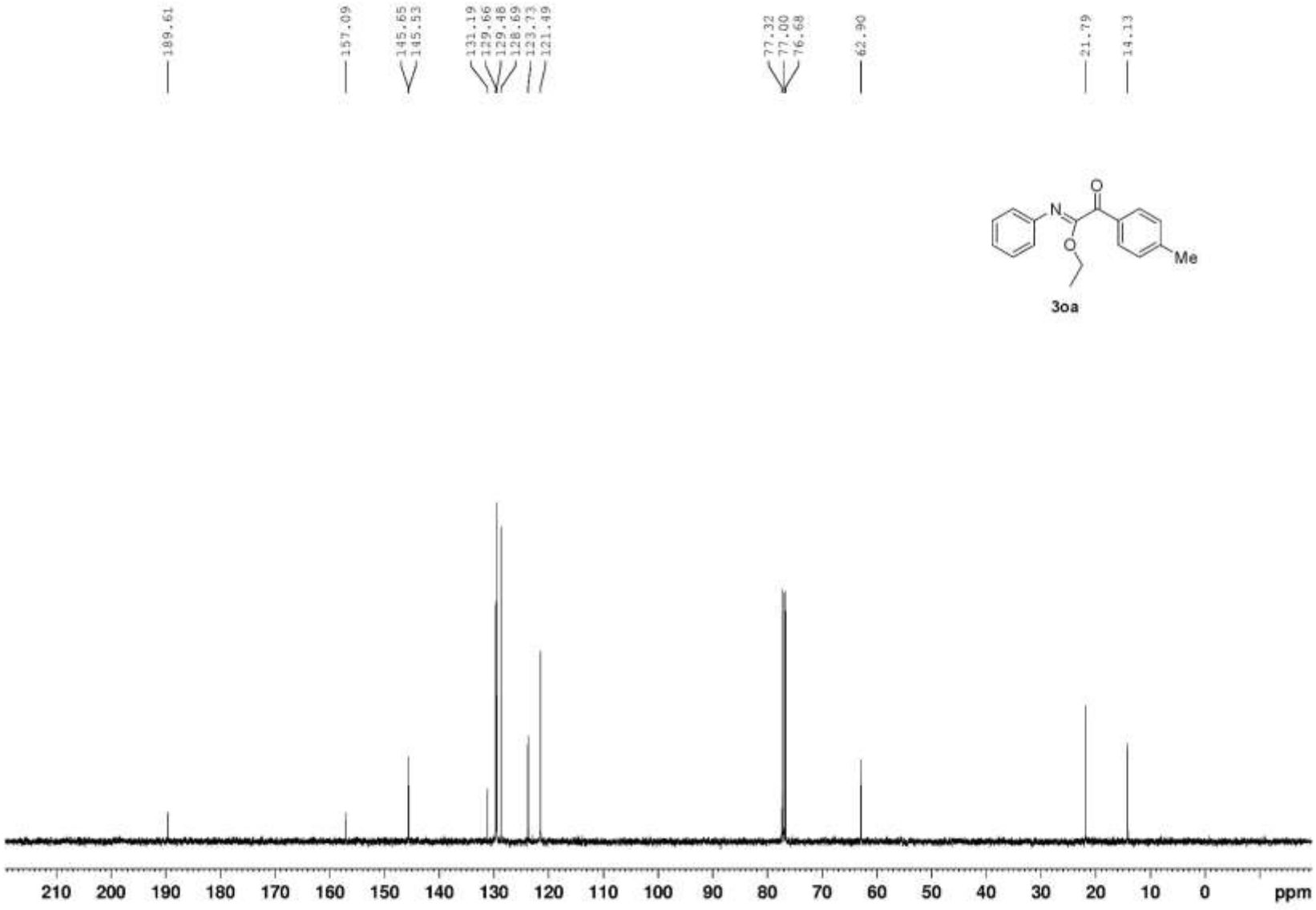

7.816
7.797
7.582
7.564
7.548
7.545
7.453
7.433
7.414
7.269
6.924
6.905
6.665
6.646
6.442
4.557
4.539
4.521
4.504
2.196
2.098
1.497
1.479
1.462
0.016
3ma
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
1.06
2.09
1.02
1.02
0.99
2.05
3.16
3.10
3.11

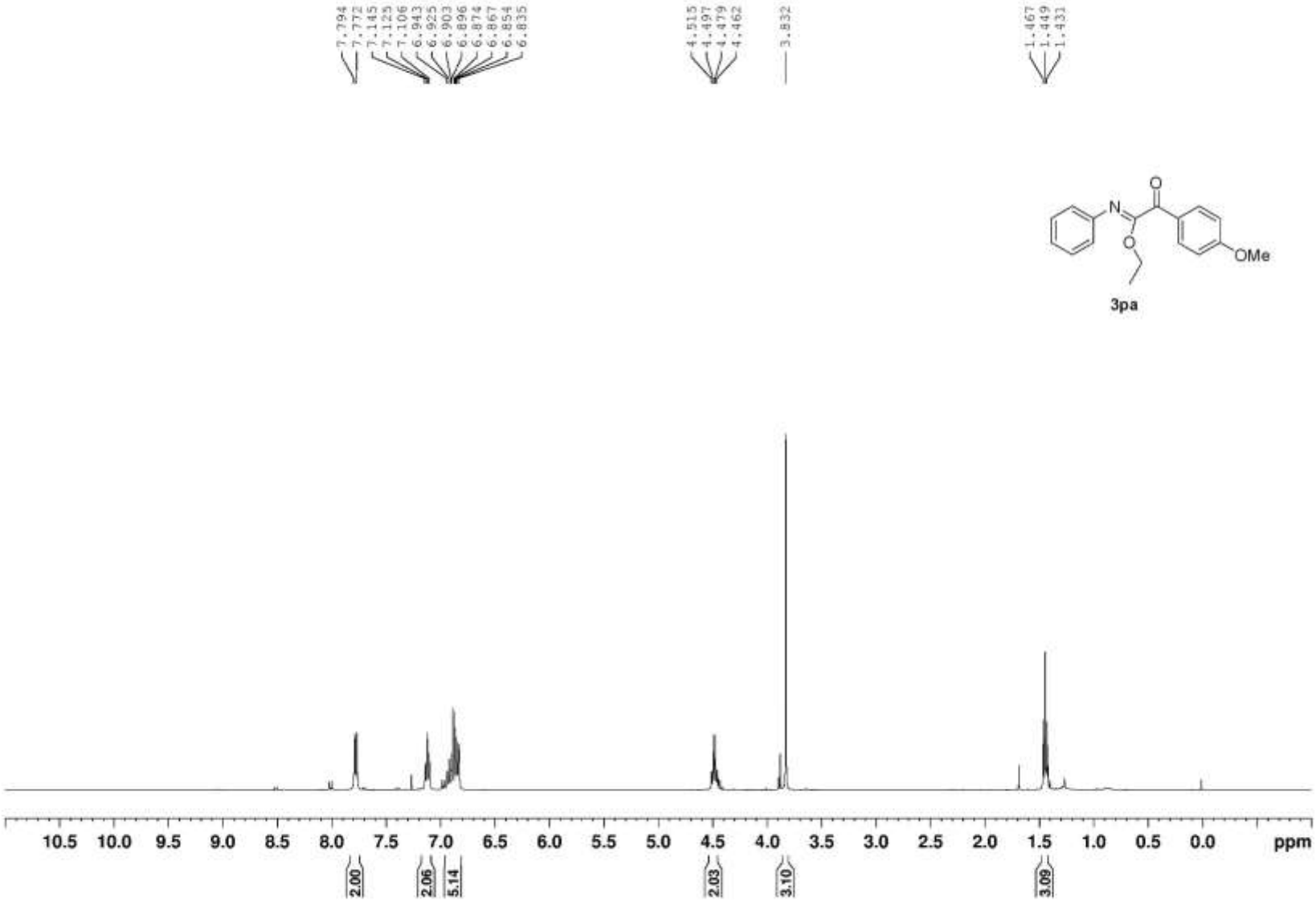

189.81
155.62
143.78
135.54
134.26
133.97
129.94
129.31
128.62
126.51
124.55
121.23
77.32
77.00
76.68
62.83
20.73
17.65
14.27
O
N
O
3ma
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

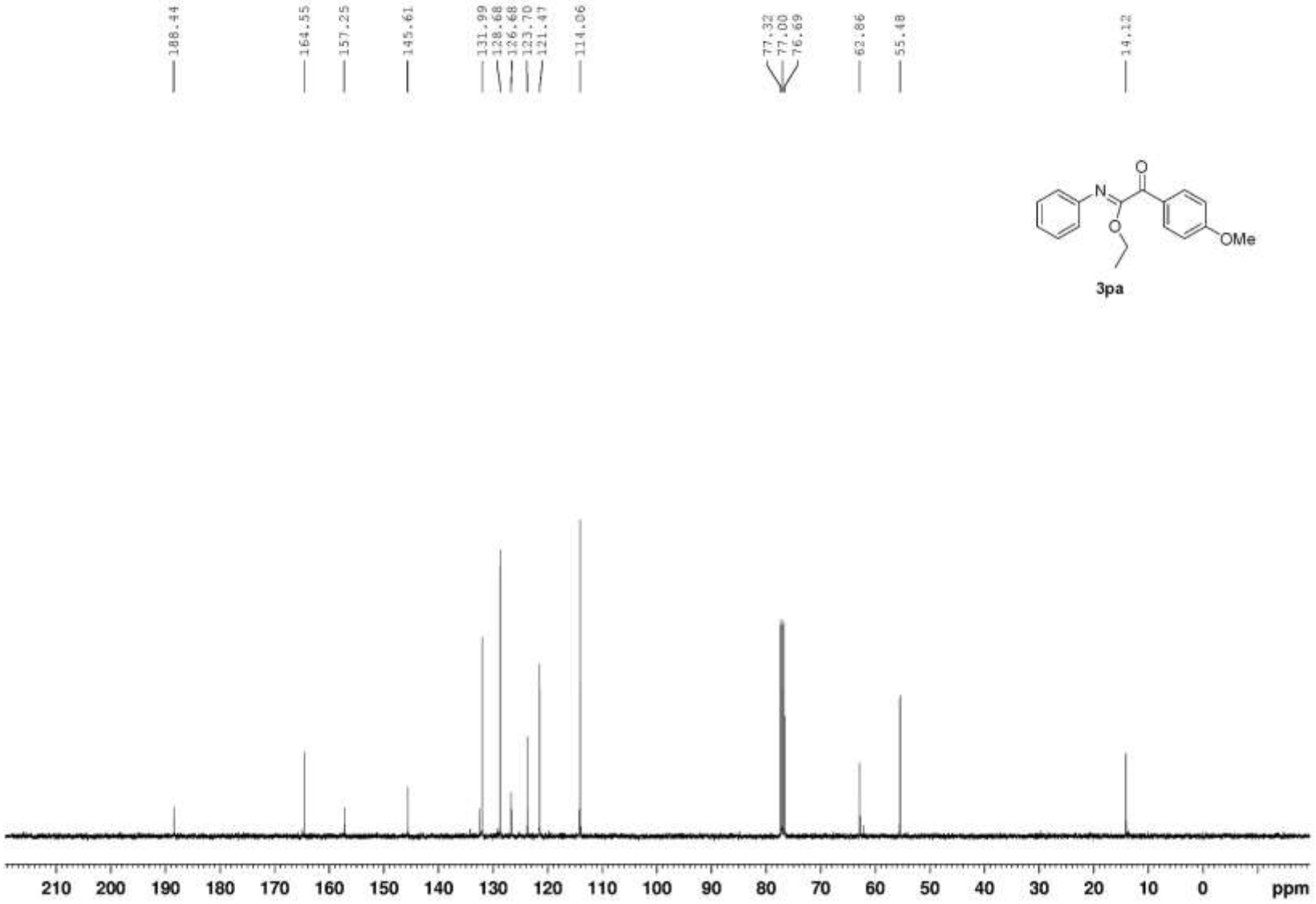

8.177
8.157
7.753
7.734
7.691
7.671
7.498
7.495
7.478
7.460
7.457
7.437
7.434
7.416
7.413
7.409
7.399
7.396
7.388
7.378
7.359
7.251
7.231
7.219
7.212
7.151
7.132
7.112
6.787
6.768
4.690
4.672
4.654
4.637
1.540
1.522
1.505
0.000
N
O
O
3na
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.02
2.00
1.05
1.07
3.11
2.12
1.01
0.99
2.00
3.05

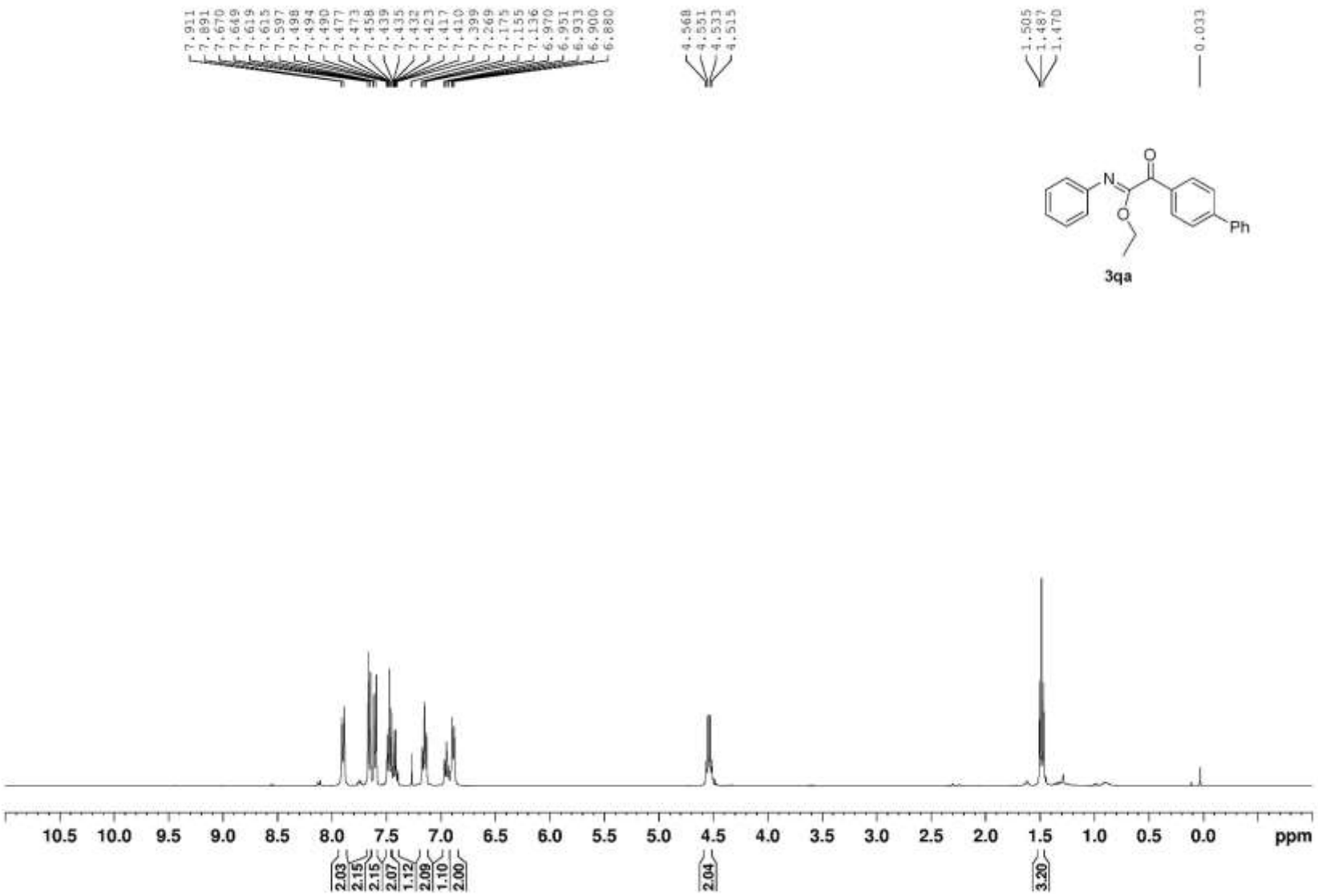

190.01
156.72
141.57
134.26
133.90
133.40
129.11
128.51
127.81
127.71
126.02
125.44
125.38
124.14
123.73
116.17
77.32
77.00
76.68
63.36
14.30
N
O
O
3na
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

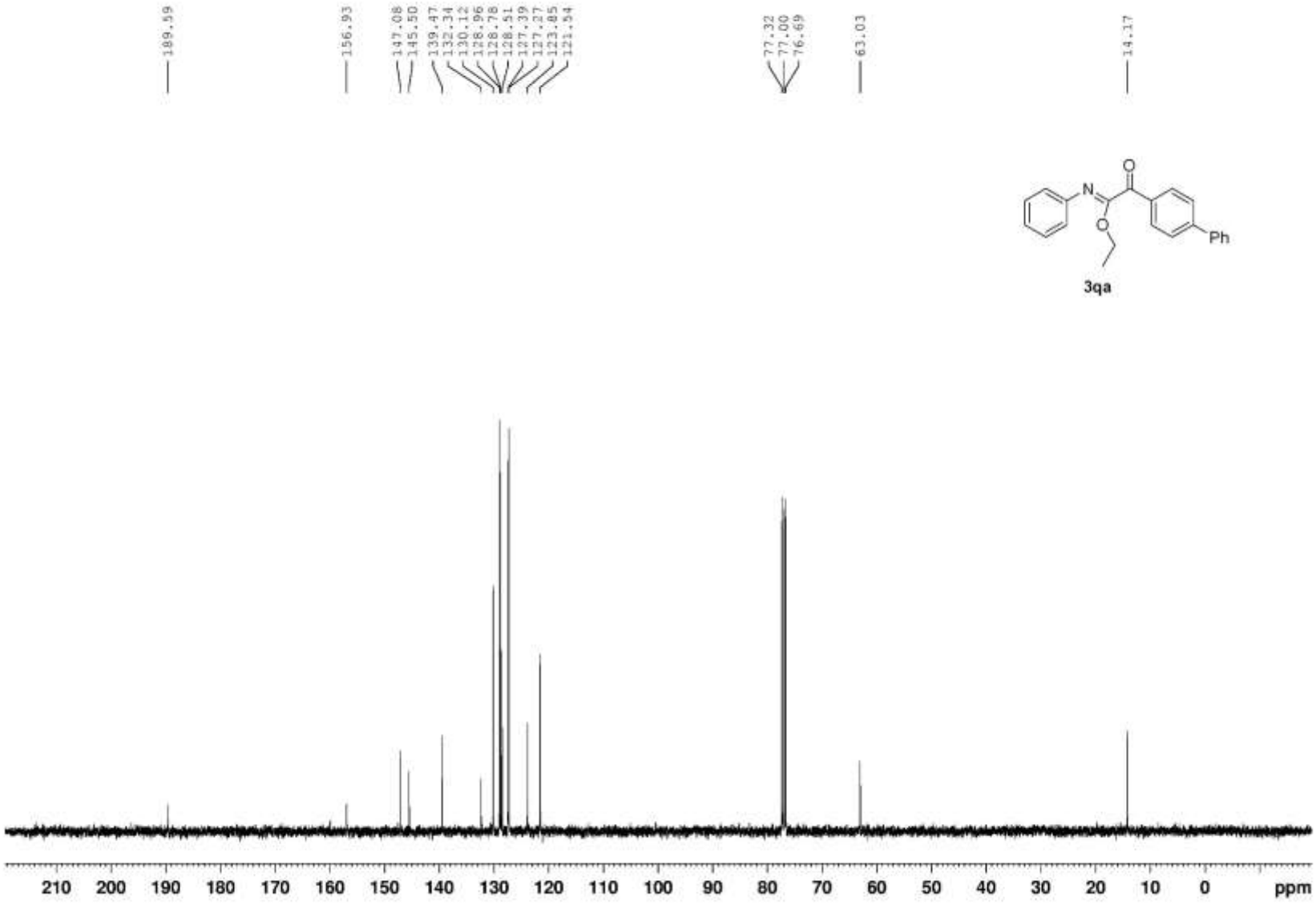

7.727
7.707
7.269
7.231
7.211
7.145
7.125
7.106
6.945
6.926
6.908
6.855
6.836
4.526
4.508
4.491
4.473
2.382
1.470
1.453
1.435
0.021
N
O
O
Me
3oa
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
2.06
2.06
1.03
2.01
2.06
3.11
3.11

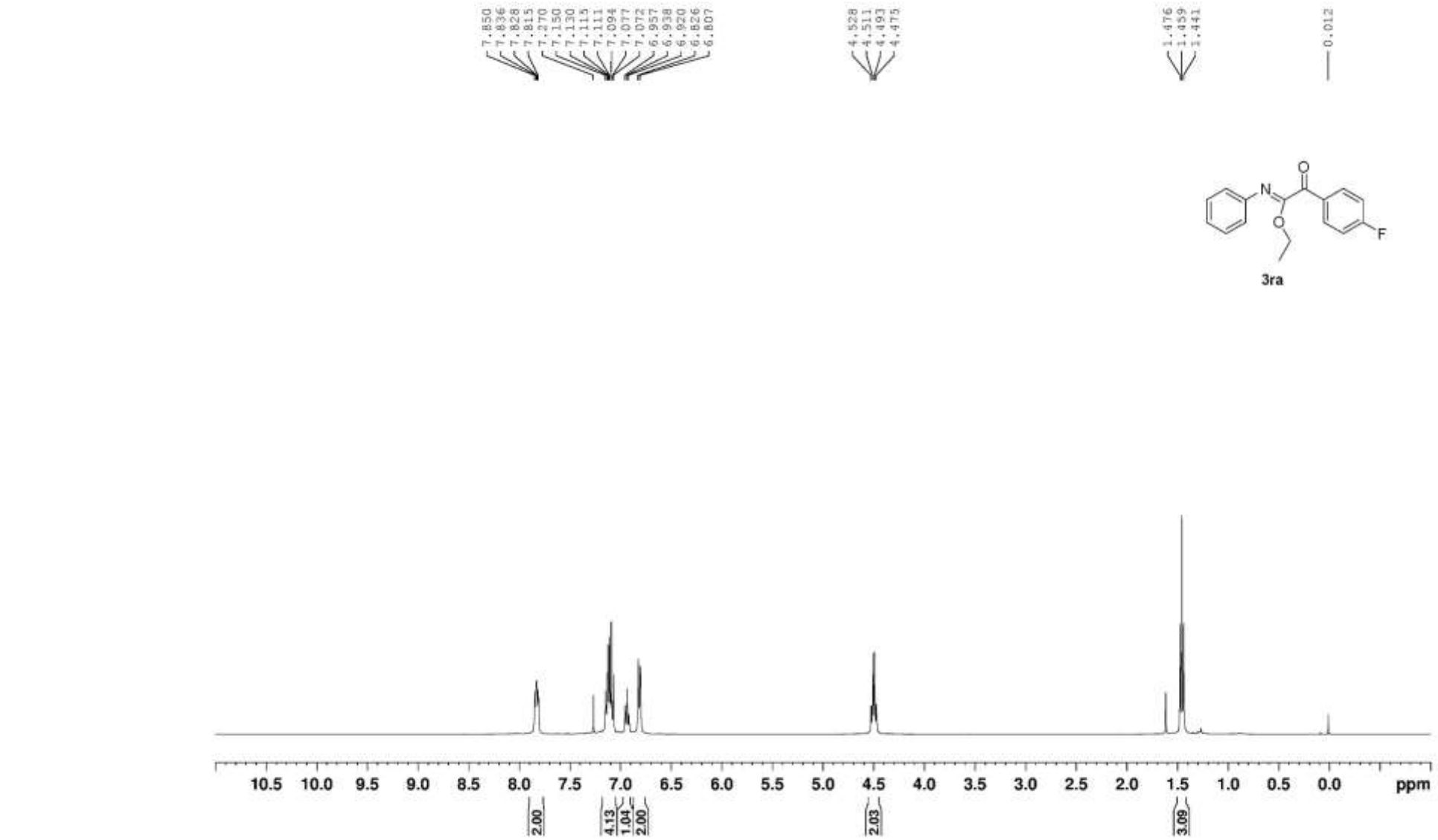

189.61
157.09
145.65
145.53
131.19
129.66
129.48
128.69
123.73
121.49
77.32
77.00
76.68
62.90
21.79
14.13
N
O
O
Me
3oa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

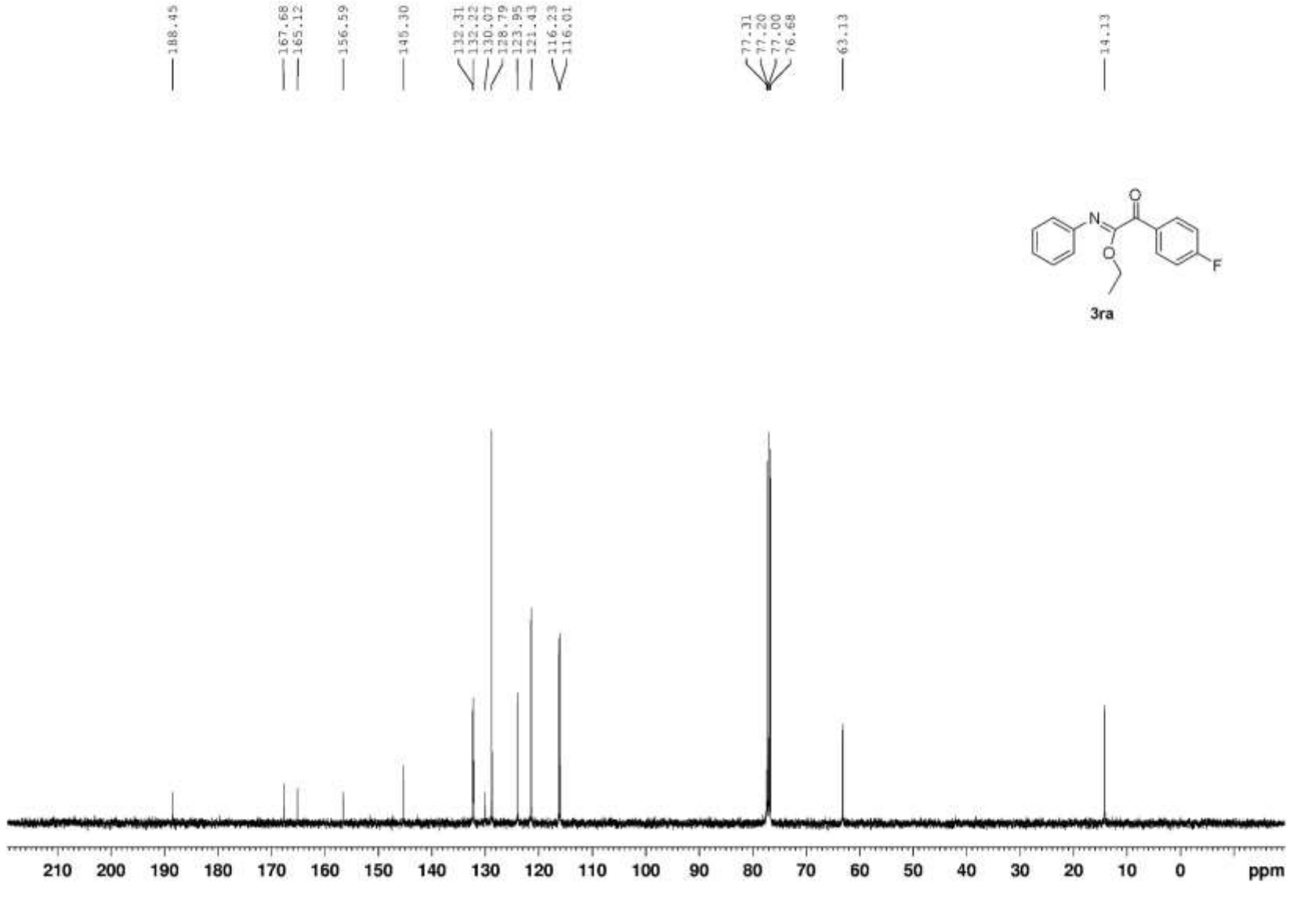

7.794
7.772
7.145
7.125
7.106
6.943
6.925
6.903
6.896
6.874
6.867
6.854
6.835
4.515
4.497
4.479
4.462
3.832
1.467
1.449
1.431
N
O
O
OMe
3pa
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
2.06
5.14
2.03
3.10
3.09

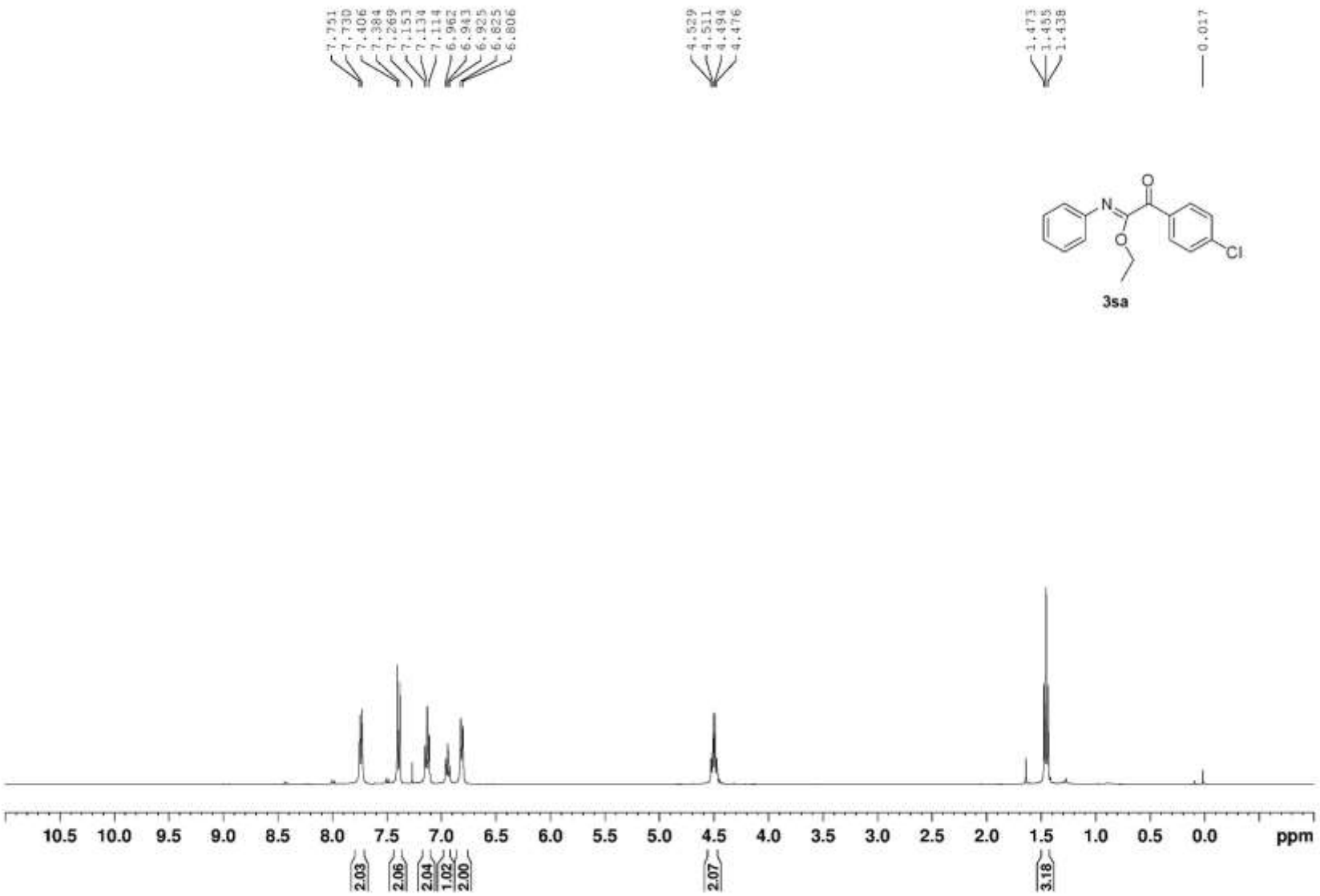

188.44
164.55
157.25
145.61
131.99
128.68
126.68
123.70
121.47
114.06
77.32
77.00
76.69
63.86
55.48
14.12
N
O
O
OMe
3pa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

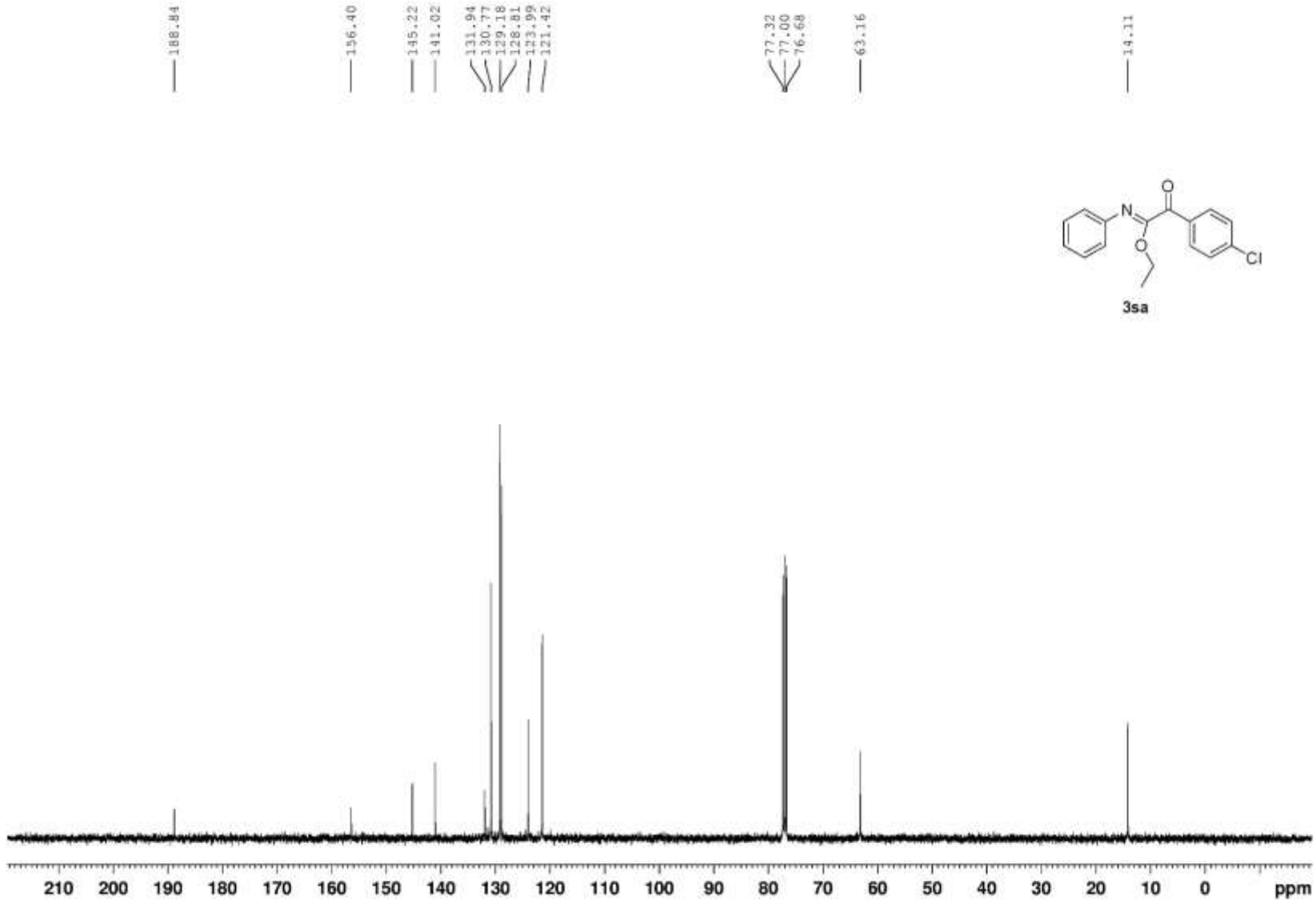

7.911
7.891
7.670
7.649
7.619
7.615
7.597
7.498
7.494
7.490
7.477
7.473
7.458
7.439
7.435
7.432
7.423
7.417
7.410
7.399
7.269
7.175
7.155
7.136
6.970
6.951
6.933
6.900
6.880
4.568
4.551
4.533
4.515
1.505
1.487
1.470
0.033
N
O
O
Ph
3qa
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.03
2.15
2.15
2.07
1.12
2.09
1.10
2.00
2.04
3.20

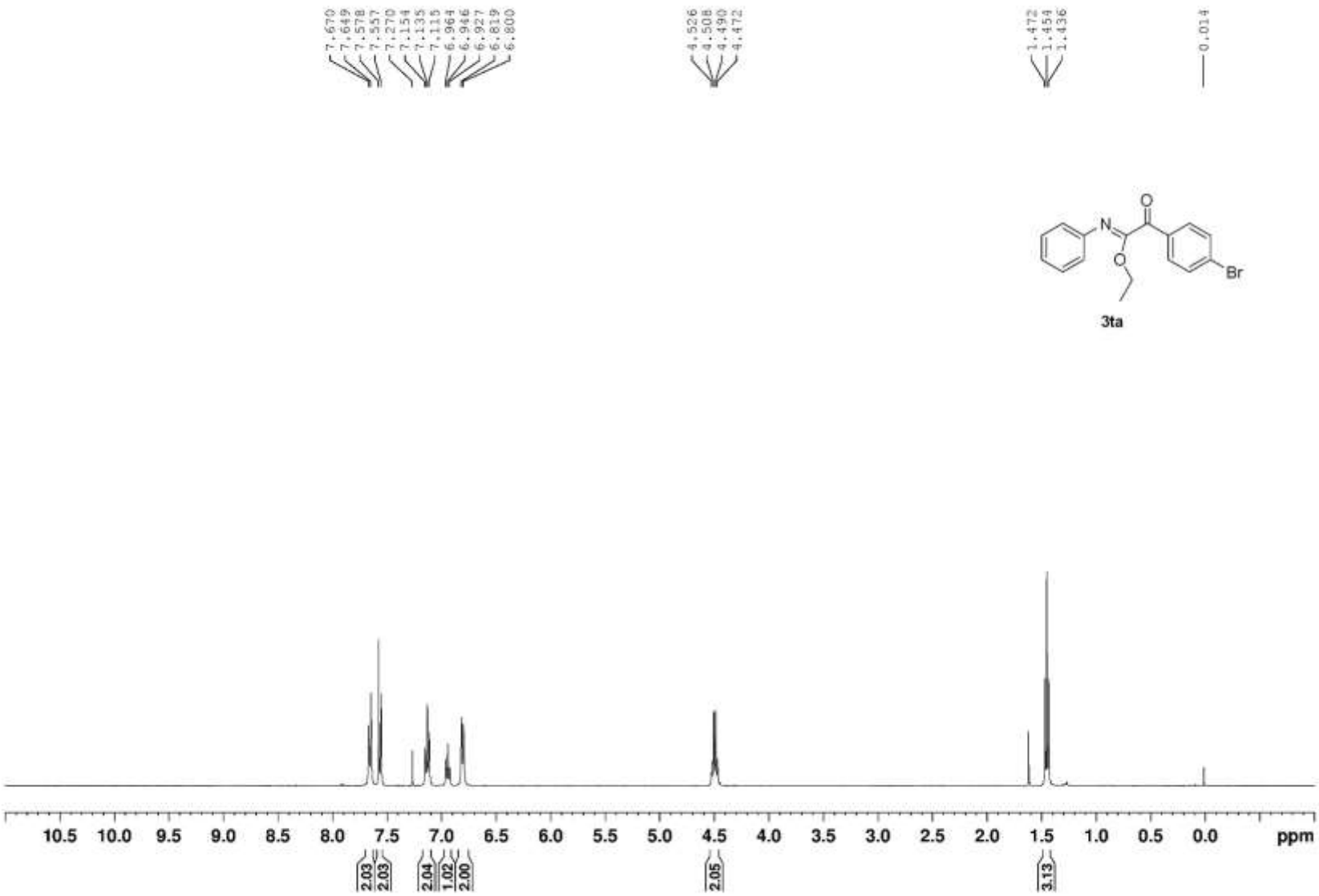

189.59
156.93
147.08
145.50
139.47
132.34
130.12
128.96
128.78
128.51
127.39
127.27
123.85
121.54
77.32
77.00
76.69
63.03
14.17
O
N
O
Ph
3qa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

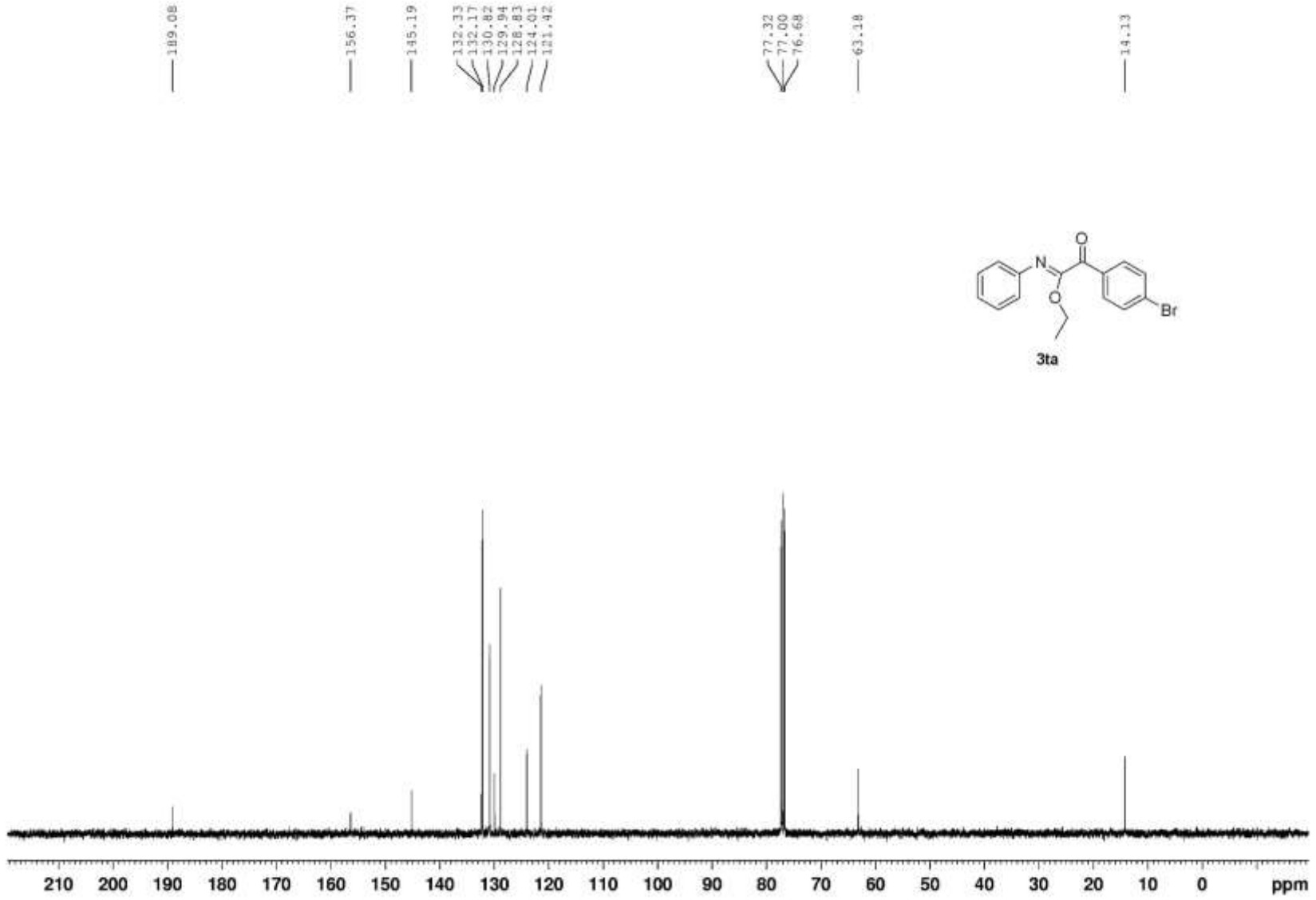

7.850
7.836
7.828
7.815
7.270
7.150
7.130
7.115
7.111
7.094
7.077
7.072
6.957
6.938
6.920
6.826
6.807
4.528
4.511
4.493
4.475
1.476
1.459
1.441
0.012
N
O
O
F
3ra
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
4.13
1.04
2.00
2.03
3.09

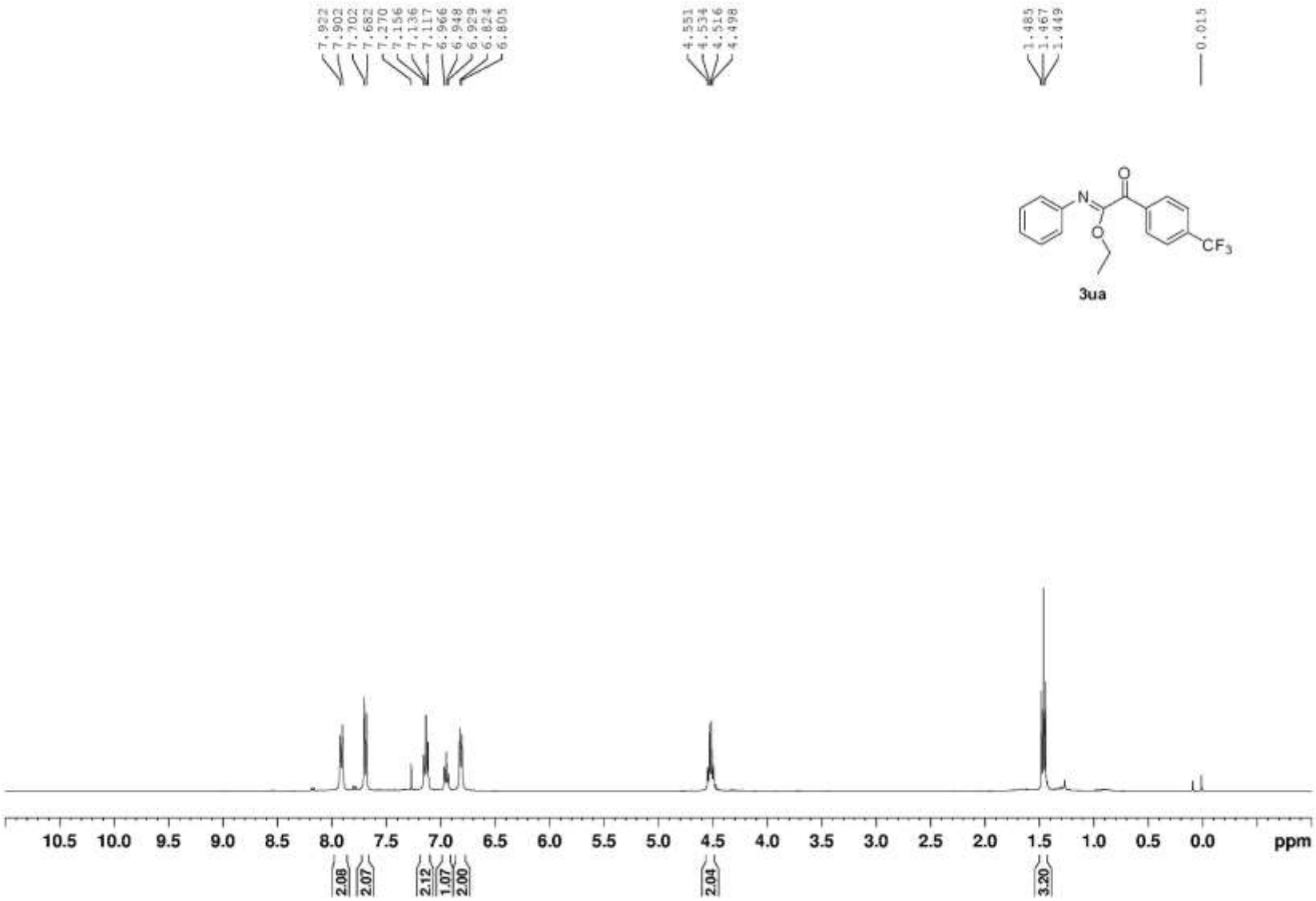

188.45
167.68
165.12
156.59
145.30
132.31
132.22
130.07
128.79
123.95
121.43
116.23
116.01
77.31
77.20
77.00
76.68
63.13
14.13
N
O
O
F
3ra
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

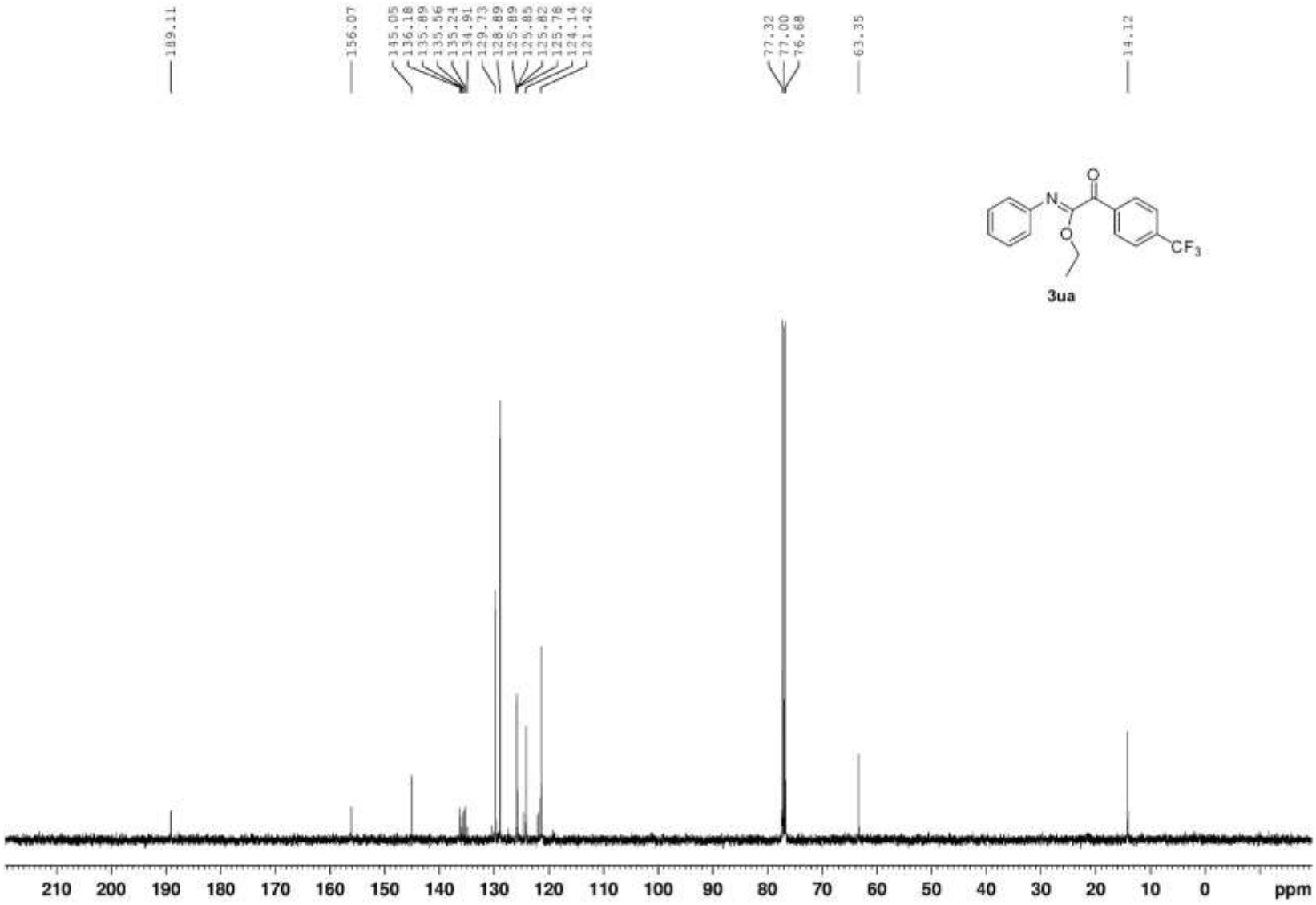

7.751
7.730
7.406
7.384
7.269
7.153
7.134
7.114
6.962
6.943
6.925
6.825
6.806
4.529
4.511
4.494
4.476
1.473
1.455
1.438
0.017
O
N
O
Cl
3sa
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.03
2.06
2.04
1.02
2.00
2.07
3.18

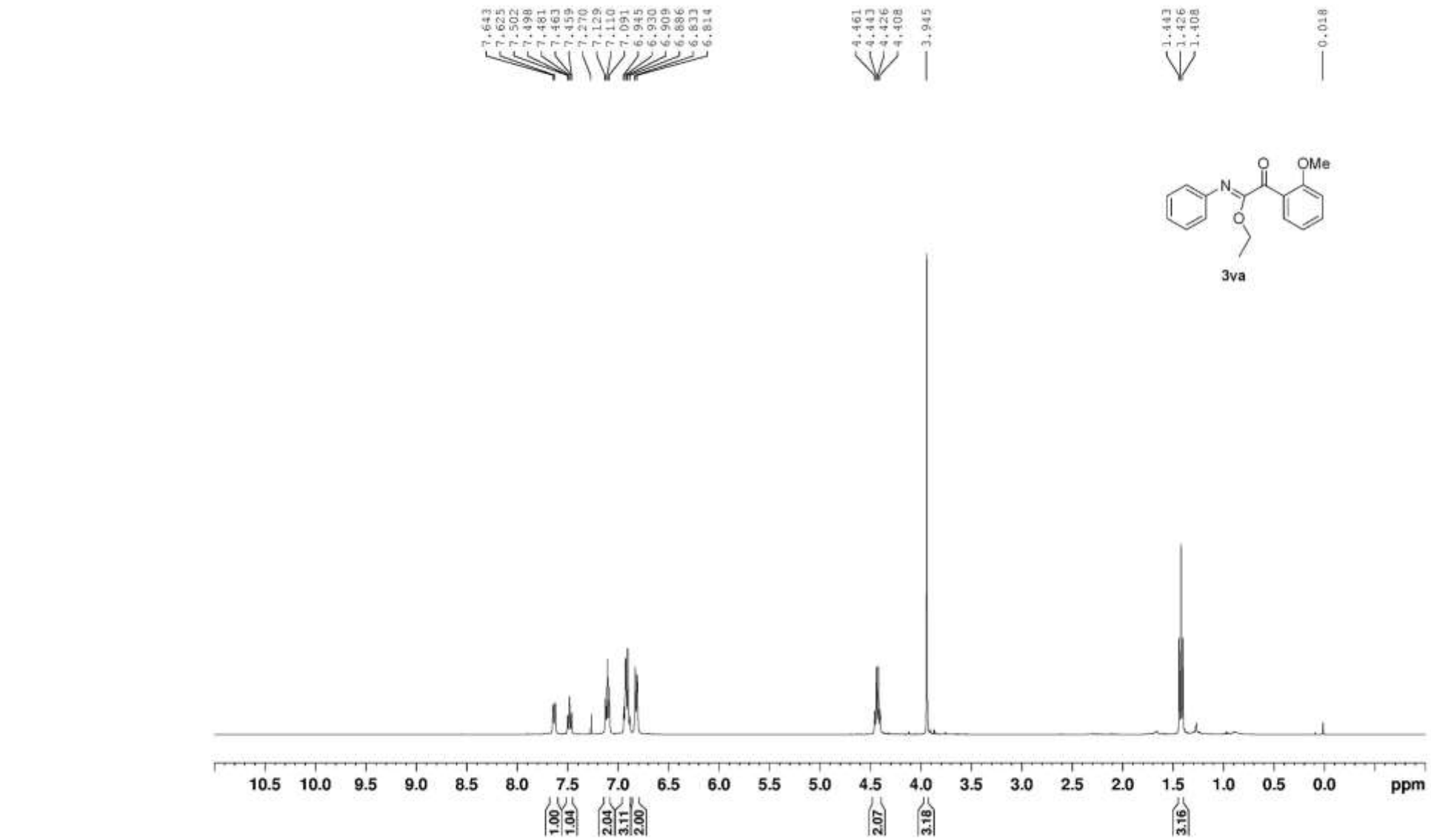

188.84
156.40
145.22
141.02
131.94
130.77
129.18
128.81
123.99
121.42
77.32
77.00
76.68
63.16
14.11
N
O
O
Cl
3sa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

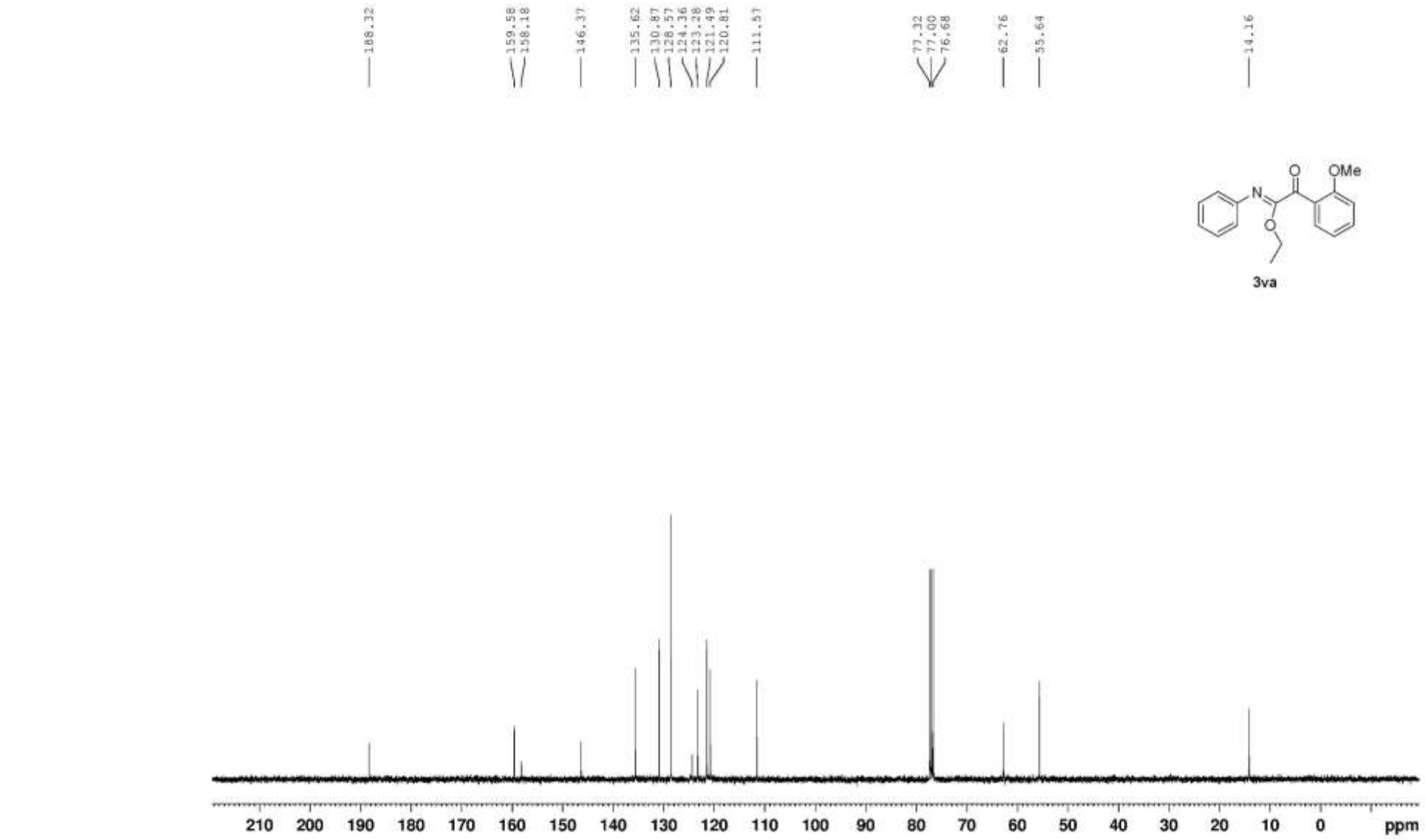

7.670
7.649
7.578
7.557
7.270
7.154
7.135
7.115
6.964
6.946
6.927
6.819
6.800
4.526
4.508
4.490
4.472
1.472
1.454
1.436
0.014
O
N
O
Br
3ta
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.03
2.03
2.04
1.02
2.00
2.05
3.13

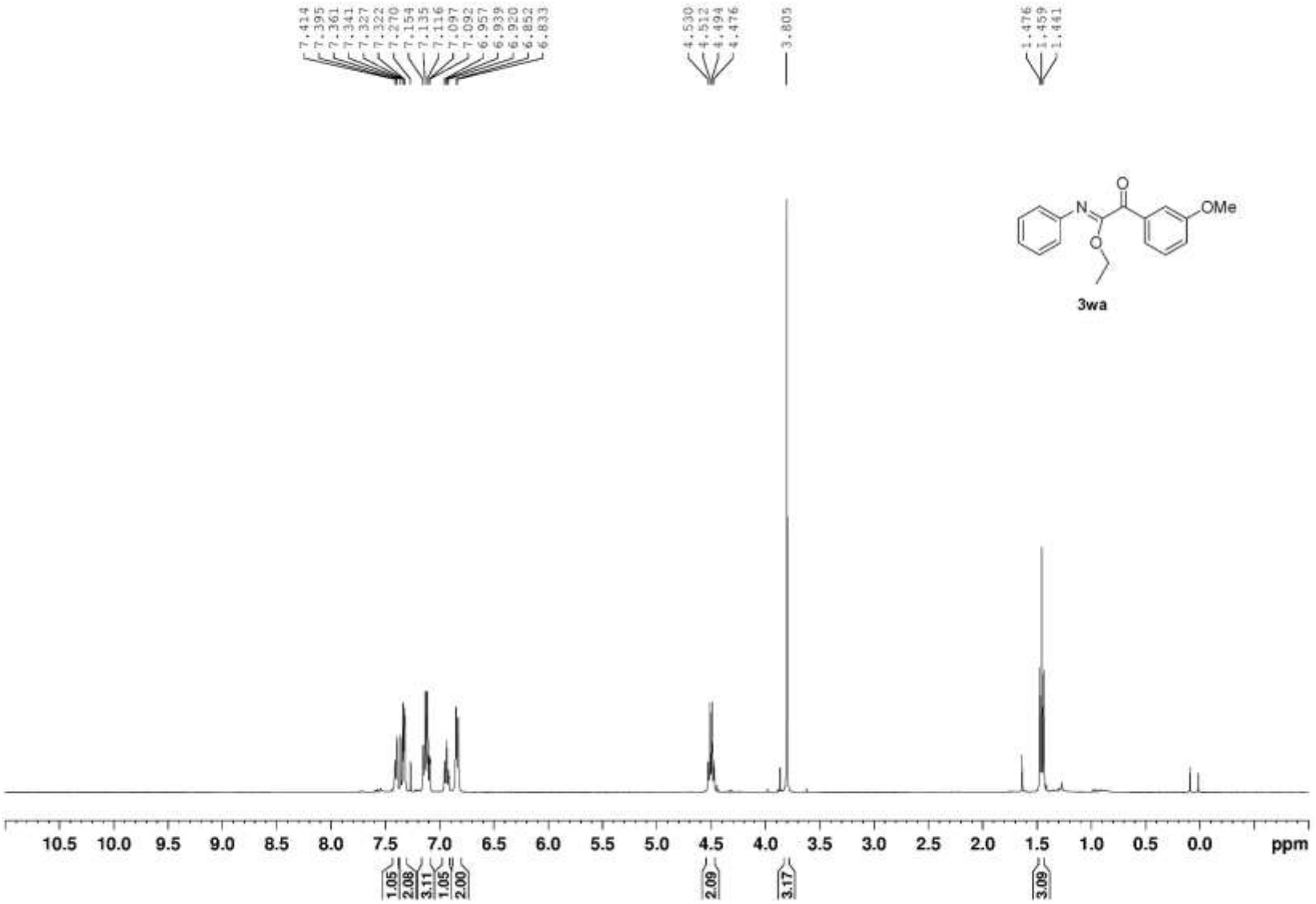

189.08
156.37
145.19
132.33
132.17
130.82
129.94
128.83
124.01
121.42
77.32
77.00
76.68
63.18
14.13
N
O
O
Br
3ta
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

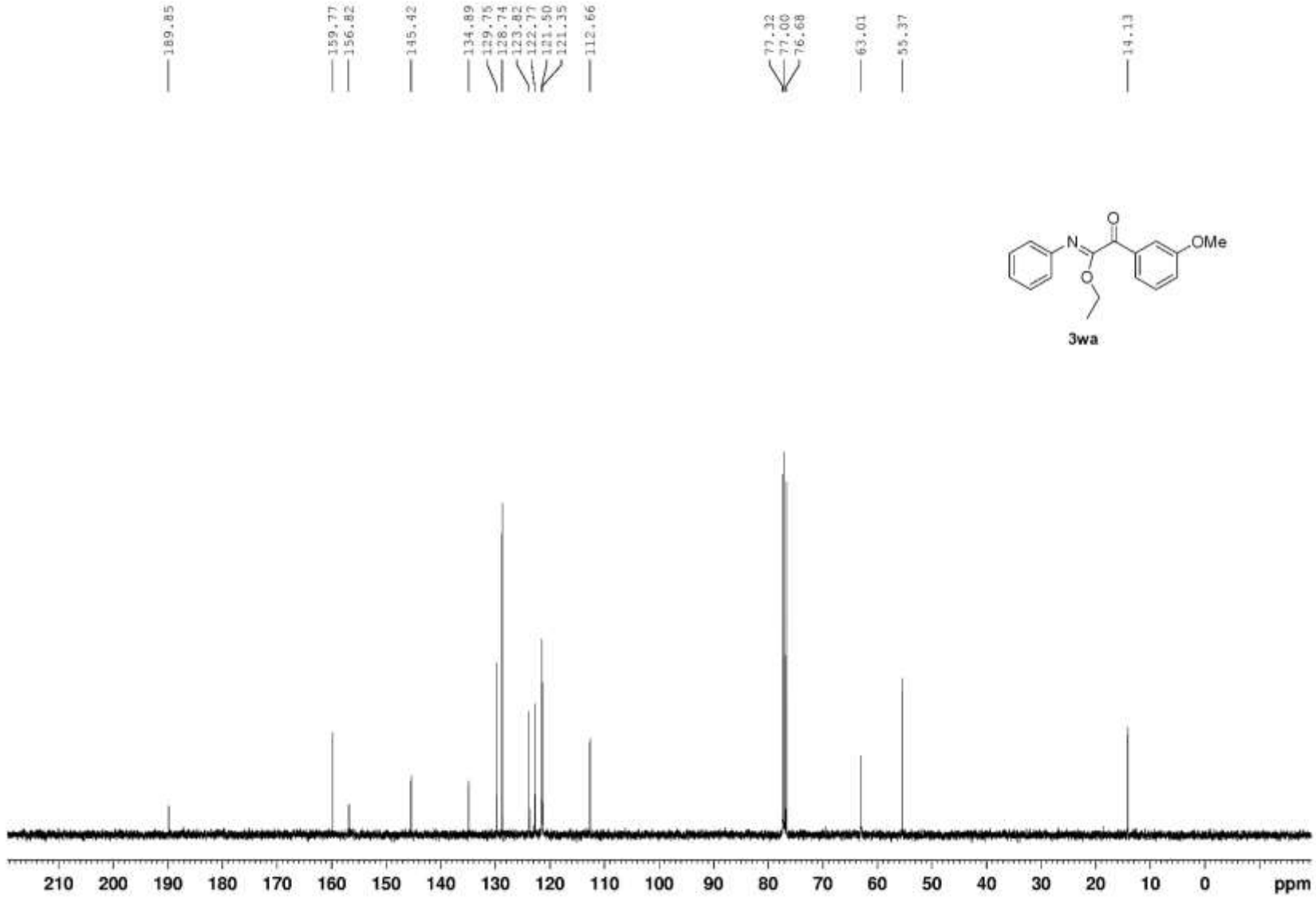

7.922
7.902
7.702
7.682
7.270
7.156
7.136
7.117
6.966
6.948
6.929
6.824
6.805
4.551
4.534
4.516
4.498
1.485
1.467
1.449
0.015
N
O
O
CF3
3ua
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.08
2.07
2.12
1.07
2.00
2.04
3.20

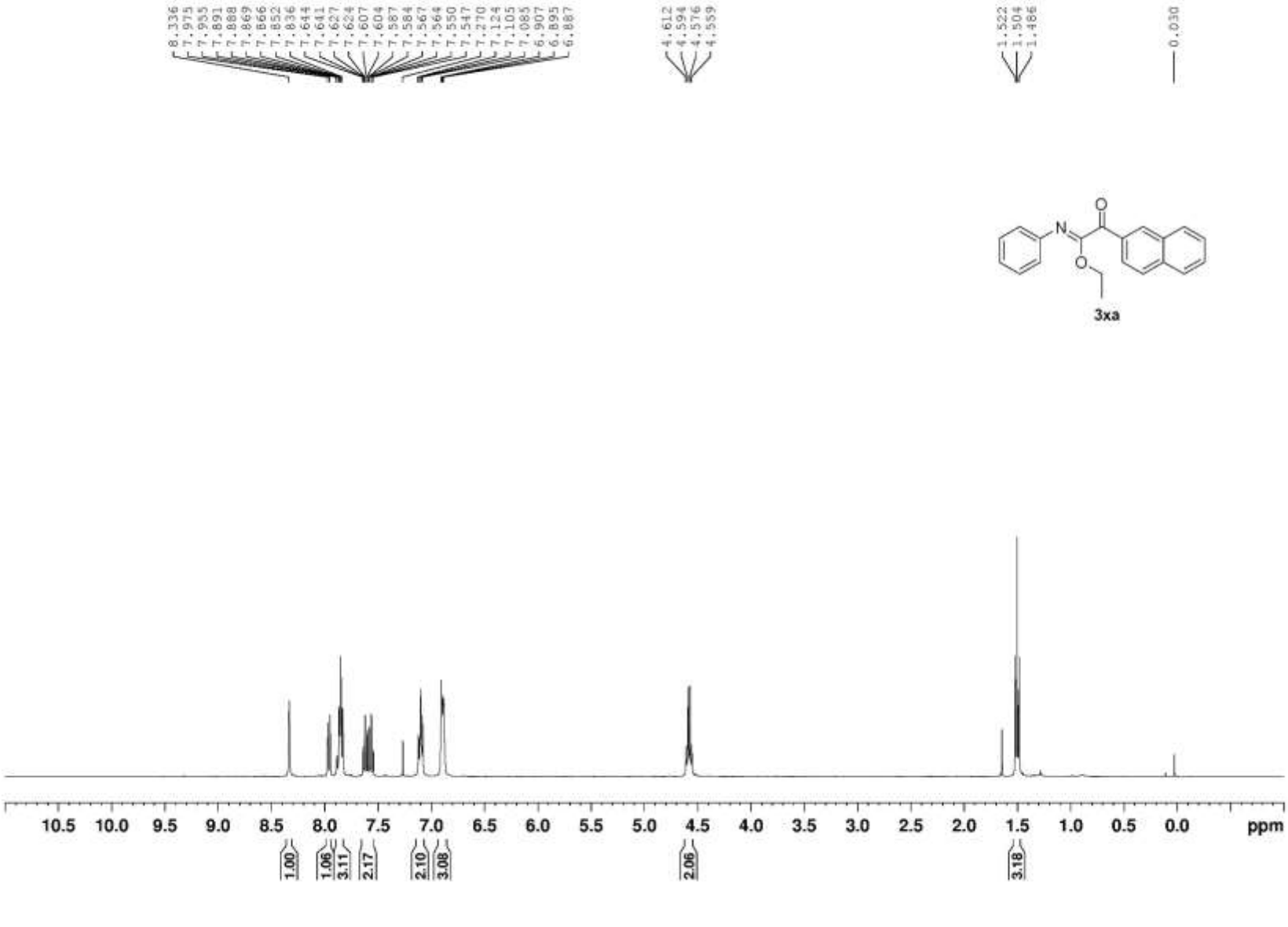

189.11
156.07
145.05
136.18
135.89
135.56
135.24
134.91
129.73
128.89
125.89
125.85
125.82
125.78
124.14
121.42
77.32
77.00
76.68
63.35
14.12
O
N
O
CF3
3ua
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

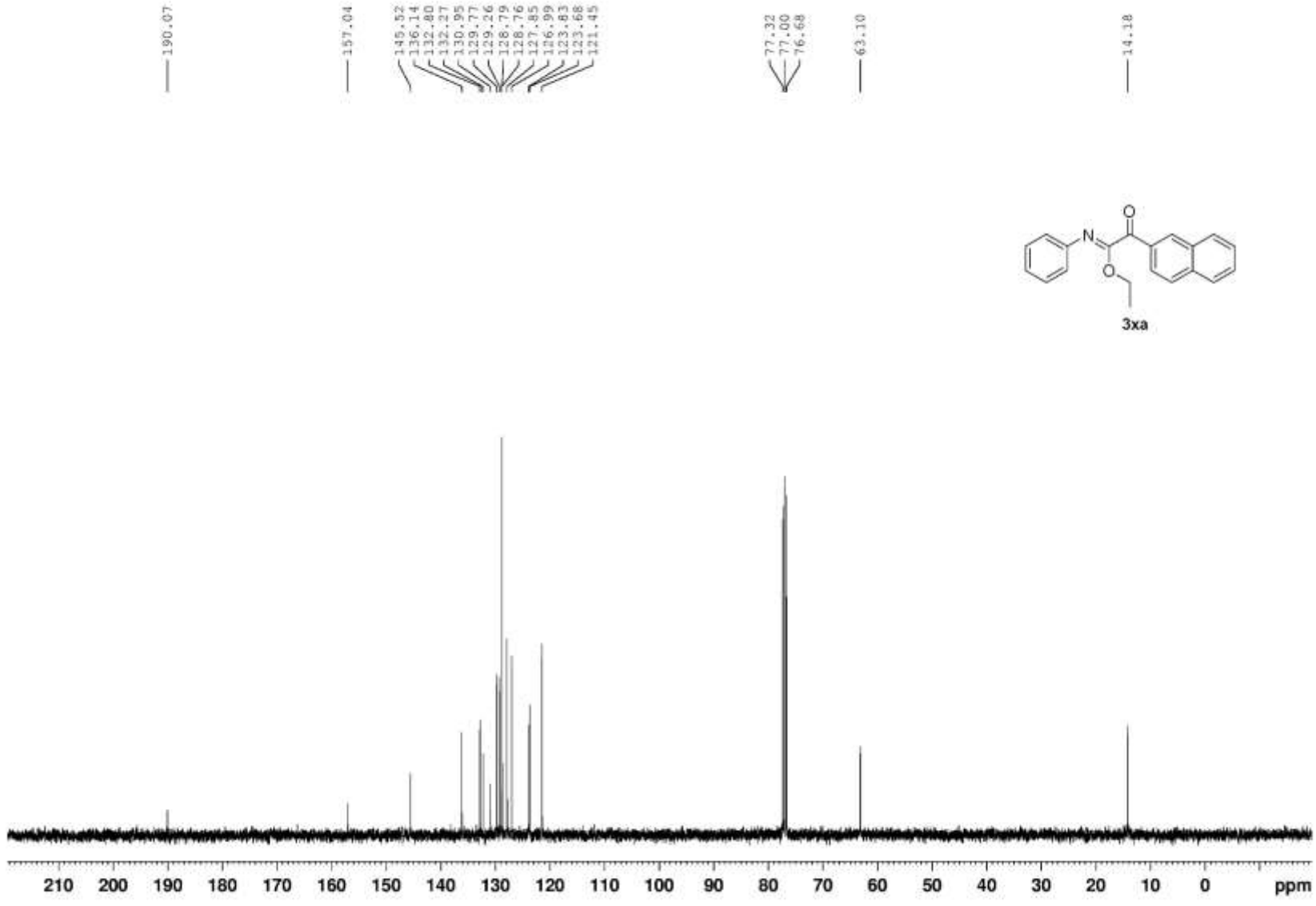

7.643
7.625
7.502
7.498
7.481
7.463
7.459
7.270
7.129
7.110
7.091
6.945
6.930
6.909
6.886
6.833
6.814
4.461
4.443
4.426
4.408
3.945
1.443
1.426
1.408
0.018
OMe
N
O
O
3va
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.00
1.04
2.04
3.11
2.00
2.07
3.18
3.16

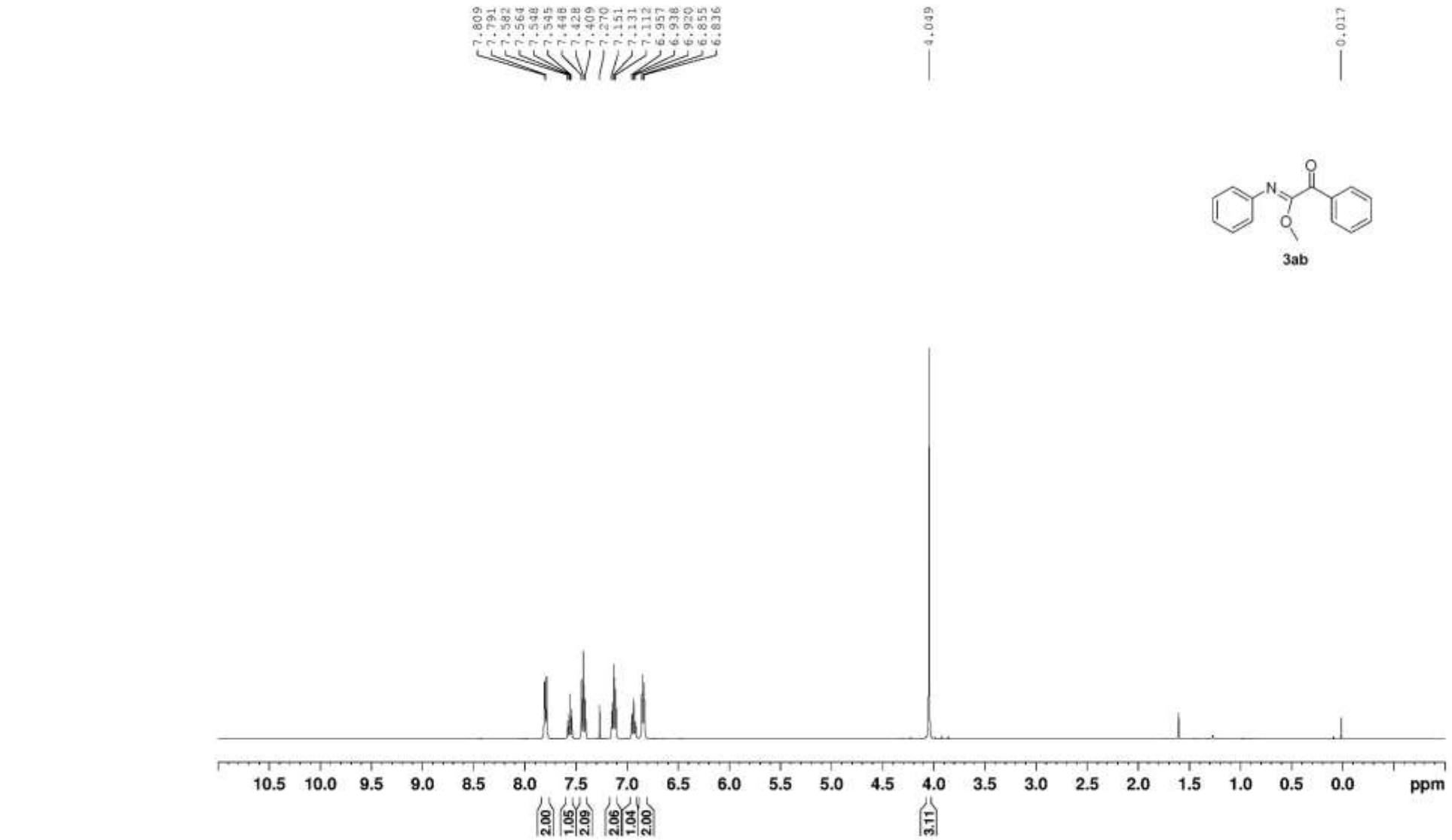

188.32
159.58
158.18
146.37
135.62
130.87
128.57
124.36
123.28
121.49
120.81
111.57
77.32
77.00
76.68
62.76
55.64
14.16
OMe
N
O
O
3va
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

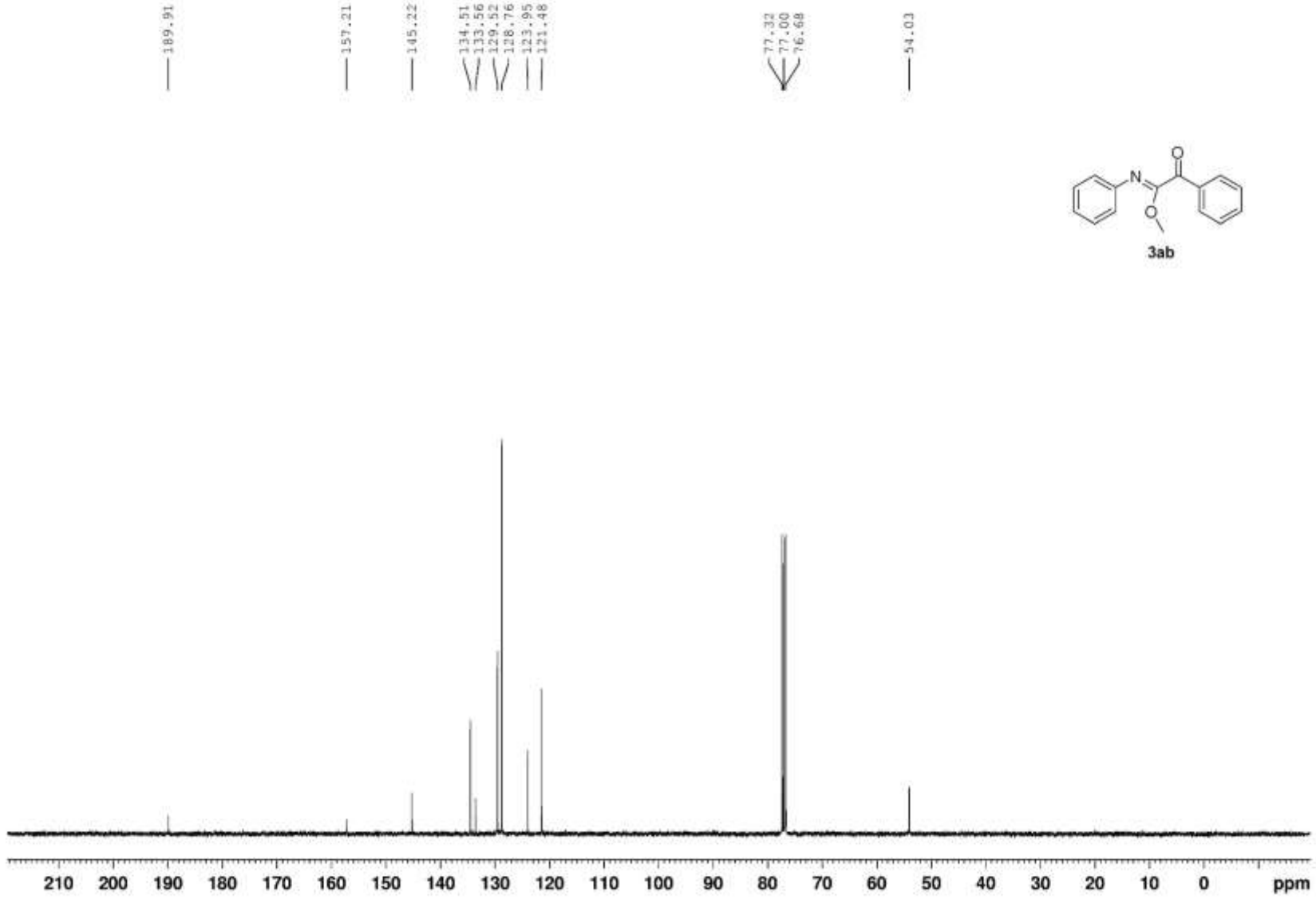

7.434
7.395
7.361
7.341
7.327
7.322
7.270
7.154
7.135
7.116
7.097
7.092
6.957
6.939
6.920
6.852
6.833
4.530
4.512
4.494
4.476
3.805
1.476
1.459
1.441
N
O
O
OMe
3wa
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.05
2.08
3.11
1.05
2.00
2.09
3.17
3.09

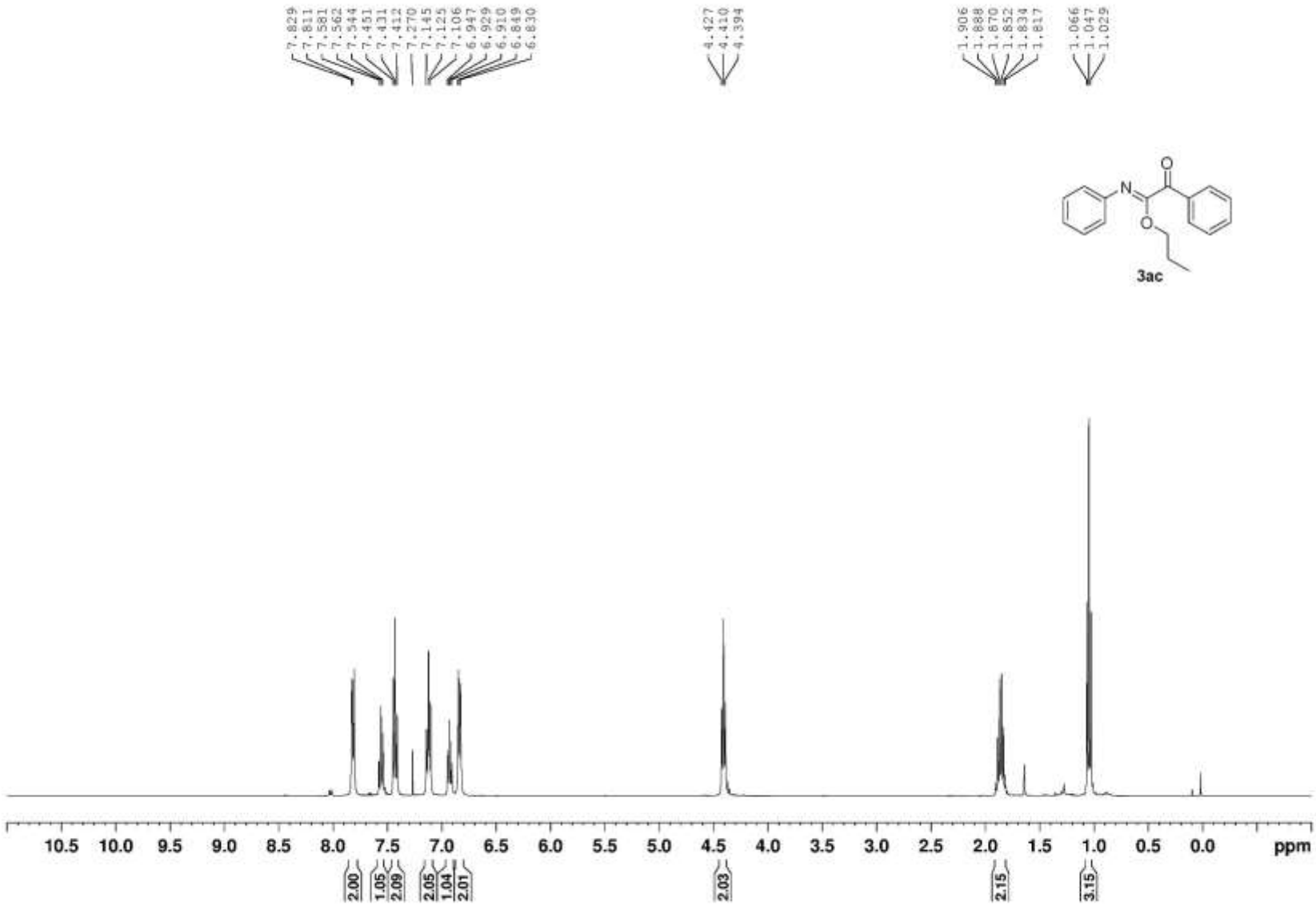

189.85
159.77
156.82
145.42
134.89
129.75
128.74
123.82
122.77
121.50
121.35
112.66
77.32
77.00
76.68
63.01
55.37
14.13
N
O
O
OMe
3wa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

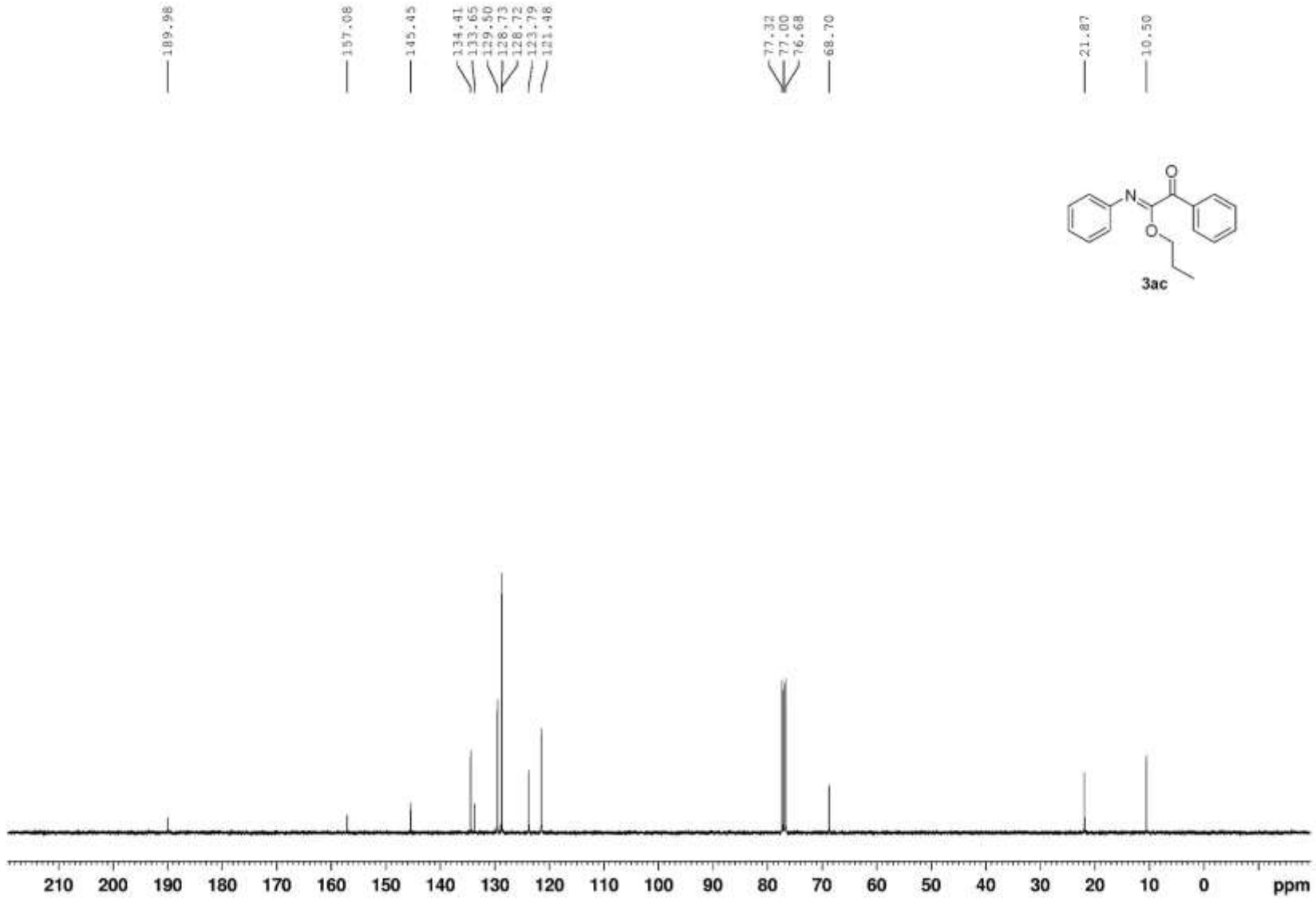

8.336
7.975
7.955
7.891
7.888
7.869
7.866
7.852
7.836
7.644
7.641
7.627
7.624
7.607
7.604
7.587
7.584
7.567
7.564
7.550
7.547
7.270
7.124
7.105
7.085
6.907
6.895
6.887
4.612
4.594
4.576
4.559
1.522
1.504
1.486
0.030
O
N
O
3xa
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.00
1.06
3.11
2.17
2.10
3.08
2.06
3.18

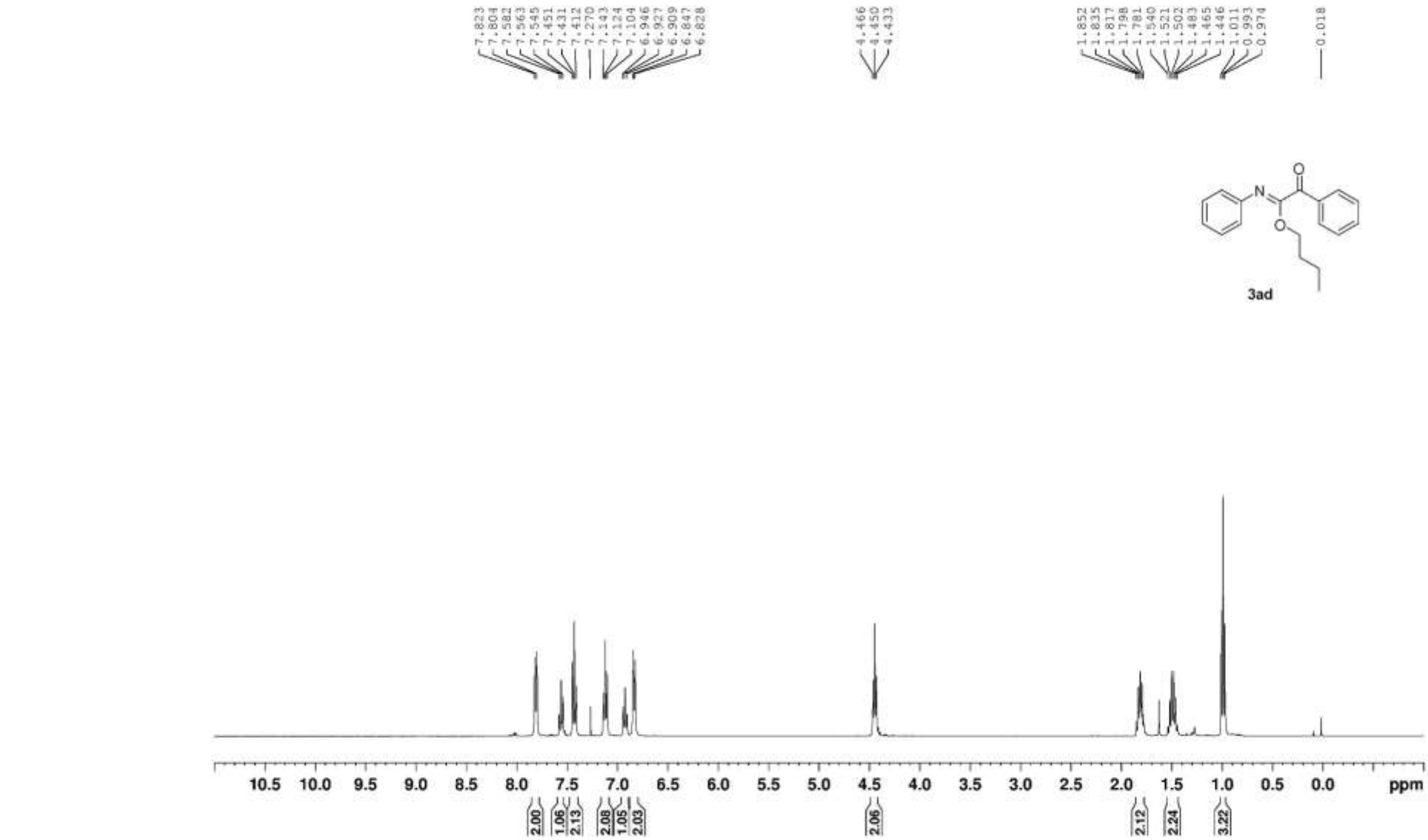

190.07
157.04
145.52
136.14
132.80
132.27
130.95
129.77
129.26
128.79
128.76
127.85
126.99
123.83
123.68
121.45
77.32
77.00
76.68
63.10
14.18
O
N
O
3xa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

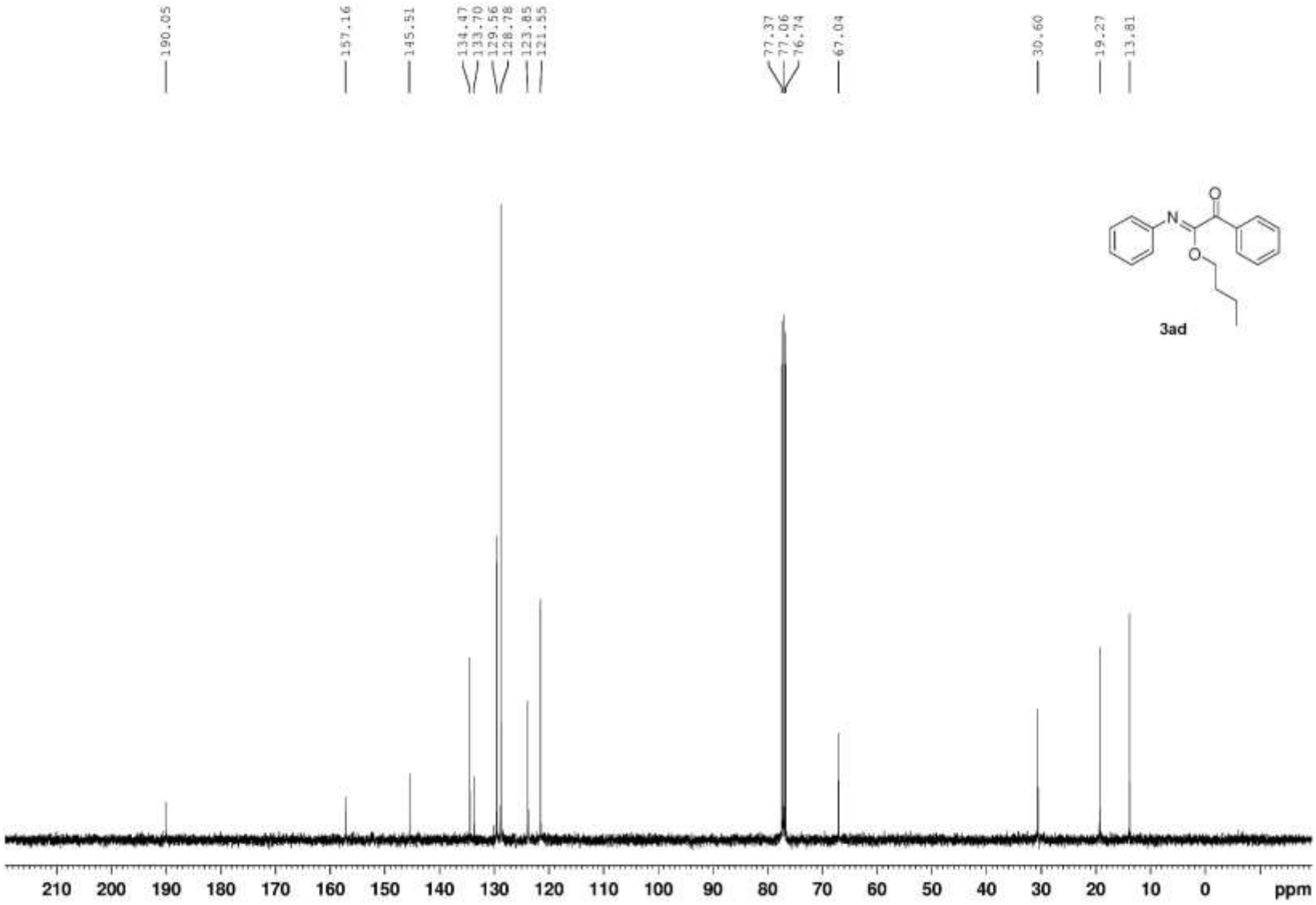

7.809
7.791
7.582
7.564
7.548
7.545
7.448
7.428
7.409
7.270
7.151
7.131
7.112
6.957
6.938
6.920
6.855
6.836
4.049
0.017
N
O
O
3ab
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.05
2.09
2.06
1.04
2.00
3.11

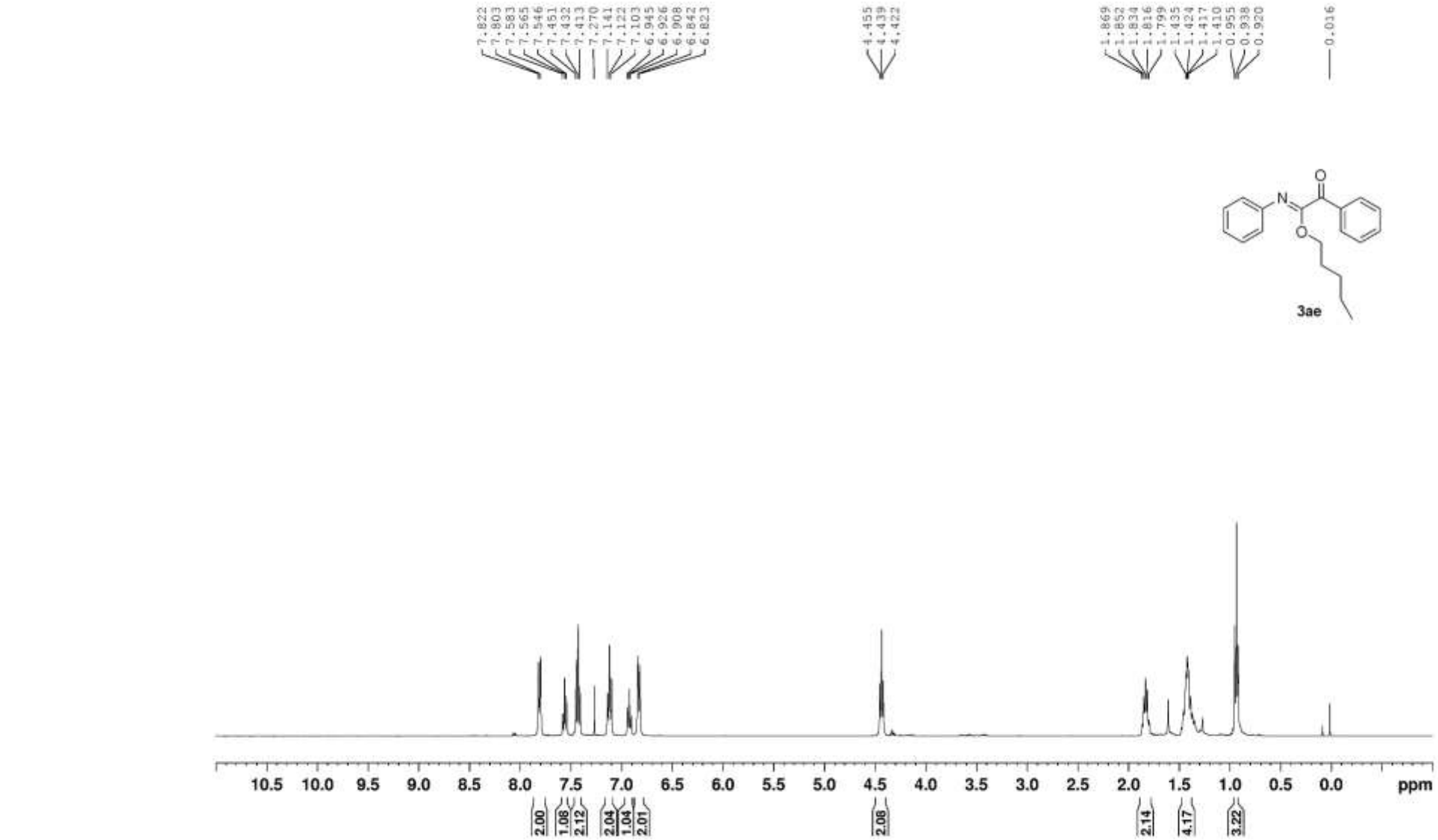

189.91
157.21
145.22
134.51
133.56
129.52
128.76
123.95
121.48
77.32
77.00
76.68
54.03
N
O
O
3ab
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

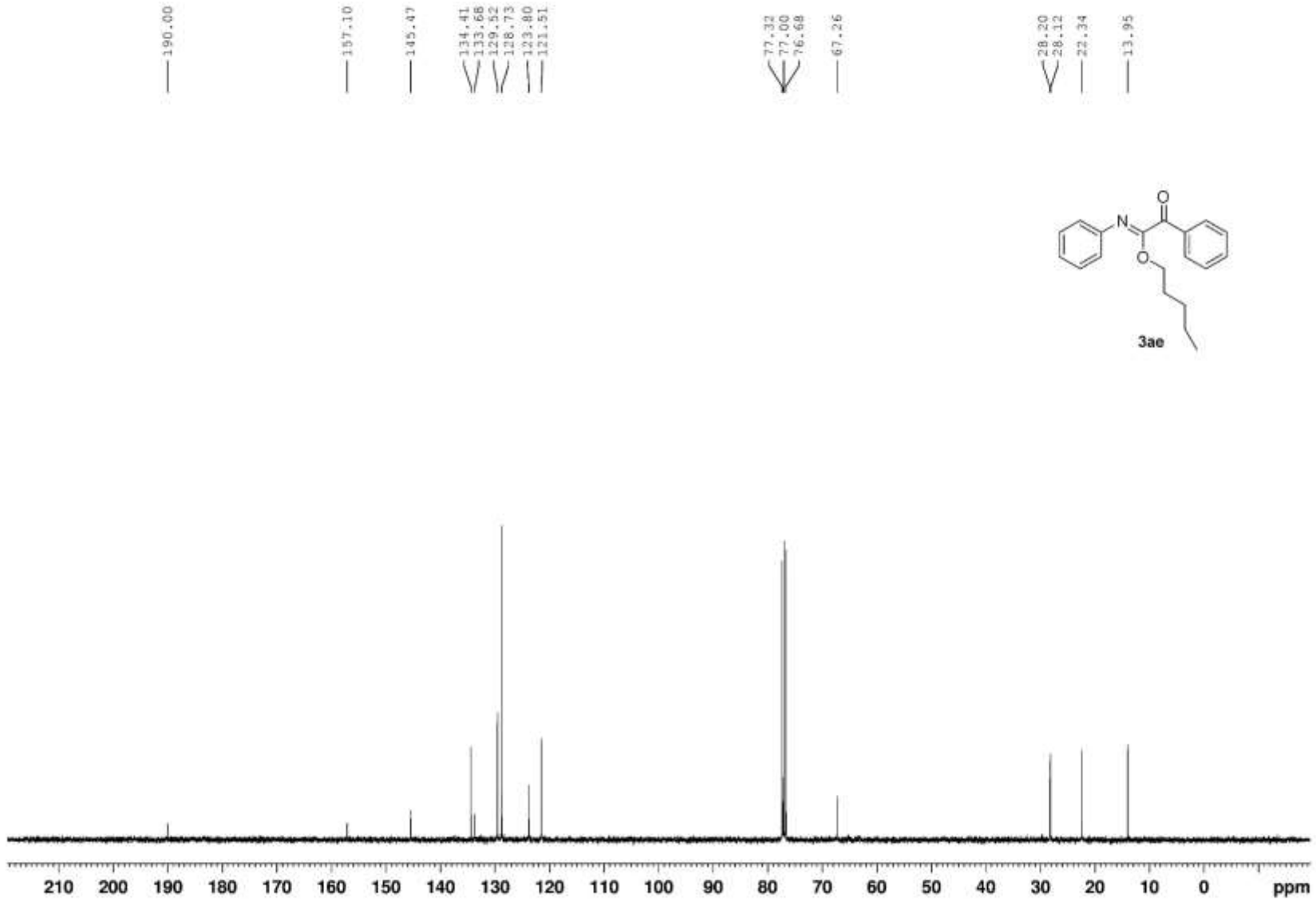

7.829
7.811
7.581
7.562
7.544
7.451
7.431
7.412
7.270
7.145
7.125
7.106
6.947
6.929
6.910
6.849
6.830
4.427
4.410
4.394
1.906
1.888
1.870
1.852
1.834
1.817
1.066
1.047
1.029
O
N
O
3ac
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.05
2.09
2.05
1.04
2.01
2.03
2.15
3.15

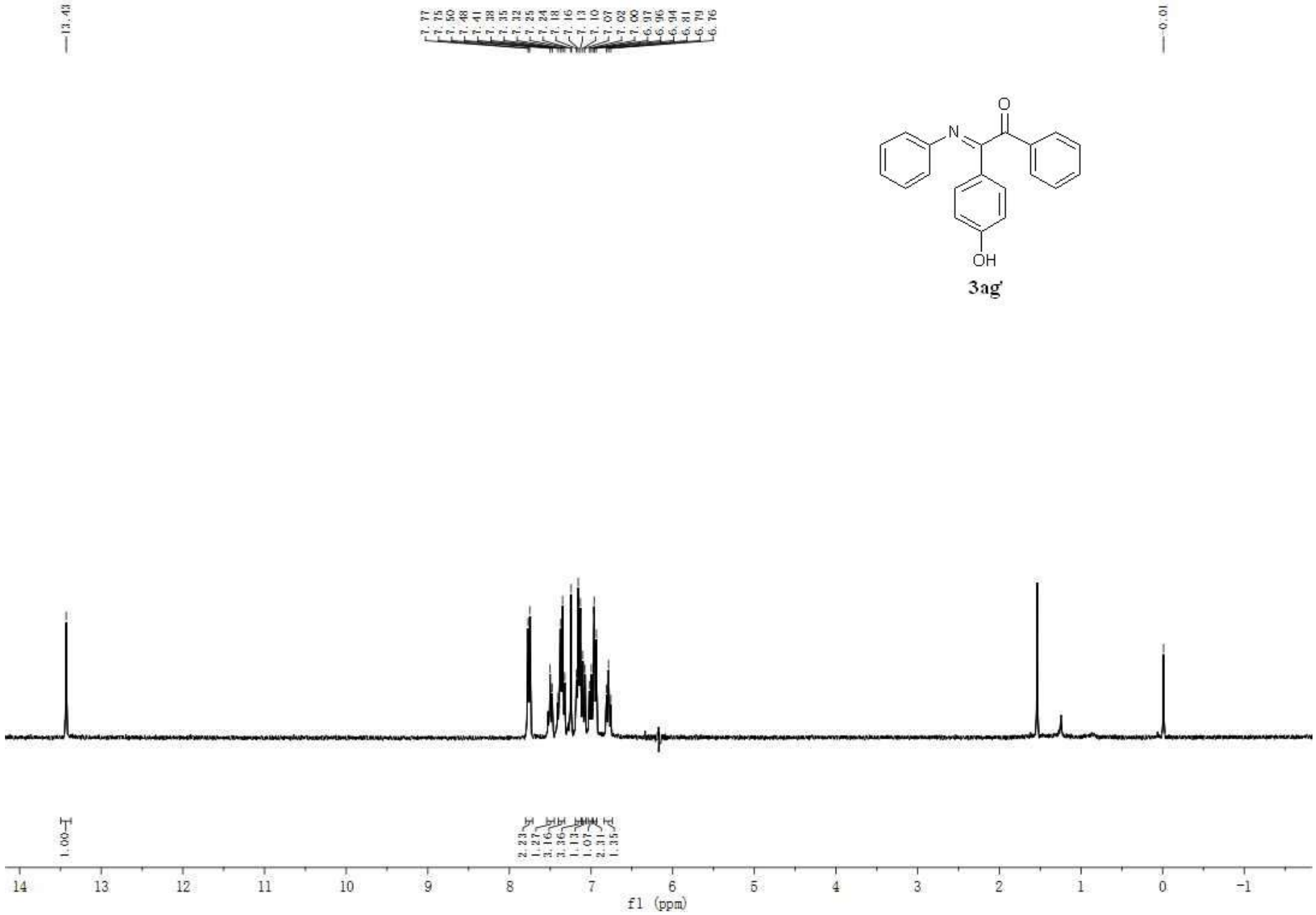

189.98
157.08
145.45
134.41
133.65
129.50
128.73
128.72
123.79
121.48
77.32
77.00
76.68
68.70
21.87
10.50
O
N
O
3ac
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm


7.823
7.804
7.582
7.563
7.545
7.451
7.431
7.412
7.270
7.143
7.124
7.104
6.946
6.927
6.909
6.847
6.828
4.466
4.450
4.433
1.852
1.835
1.817
1.798
1.781
1.540
1.521
1.502
1.483
1.465
1.446
1.011
0.993
0.974
0.018
N
O
O
3ad
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
1.06
2.13
2.08
1.05
2.03
2.06
2.12
2.24
3.22

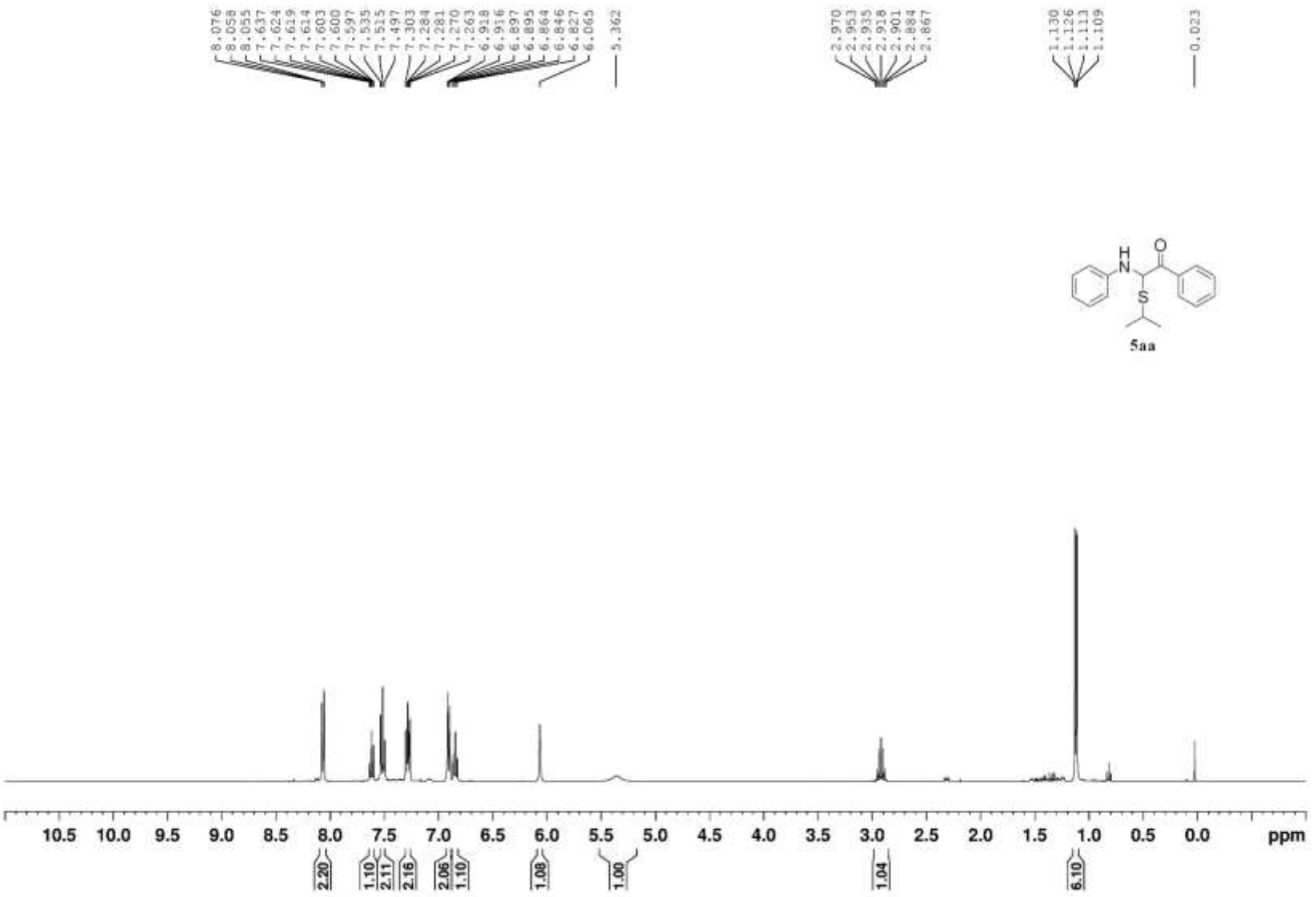

190.05
157.16
145.51
134.47
133.70
129.56
128.78
123.85
121.55
77.37
77.06
76.74
67.04
30.60
19.27
13.81
3ad
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

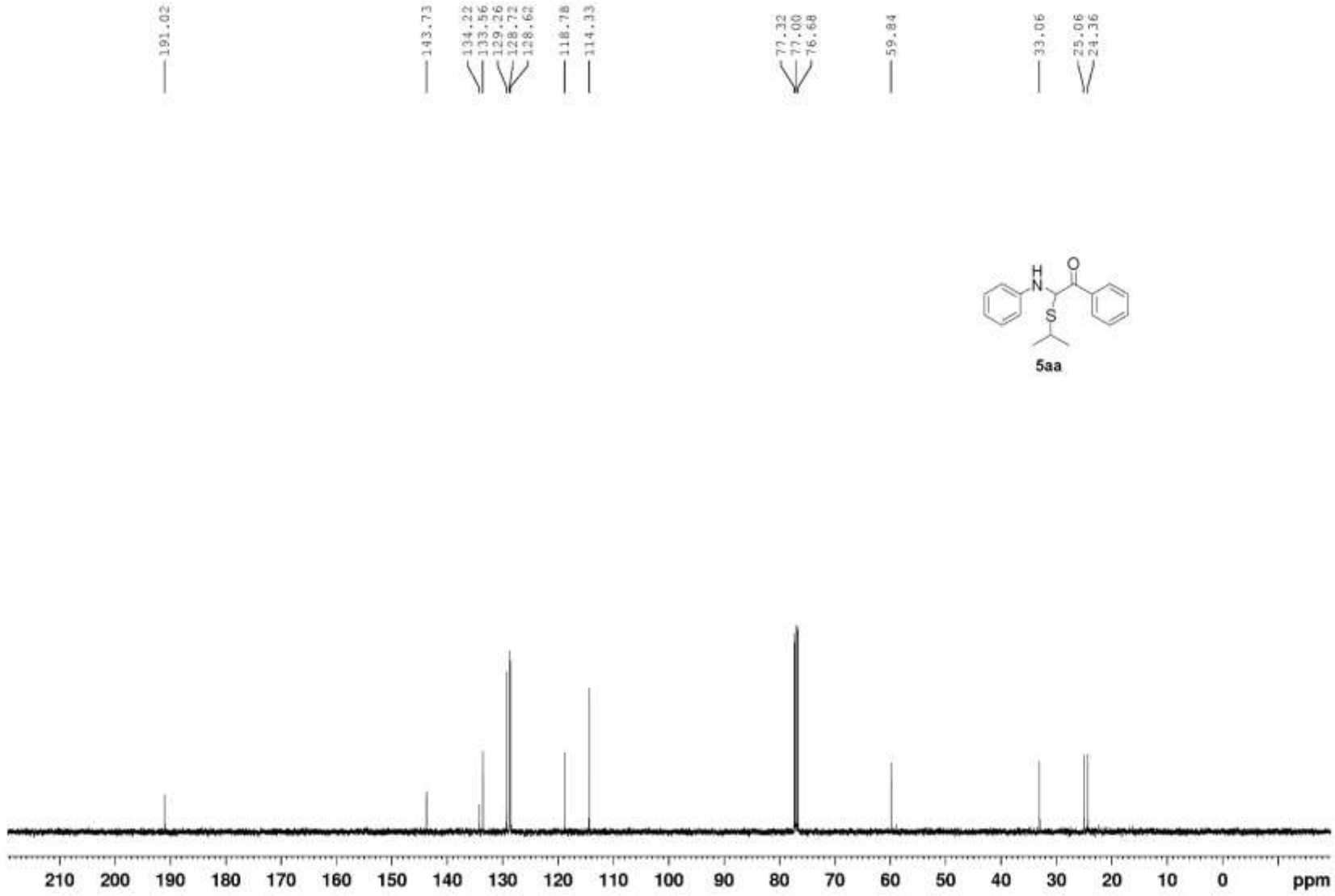

7.822
7.803
7.583
7.565
7.546
7.451
7.432
7.413
7.270
7.141
7.122
7.103
6.945
6.926
6.908
6.842
6.823
4.455
4.439
4.422
1.869
1.852
1.834
1.816
1.799
1.435
1.424
1.417
1.410
0.955
0.938
0.920
0.016
N
O
O
3ae
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
1.06
2.12
2.04
1.04
2.01
2.08
2.14
4.17
3.22

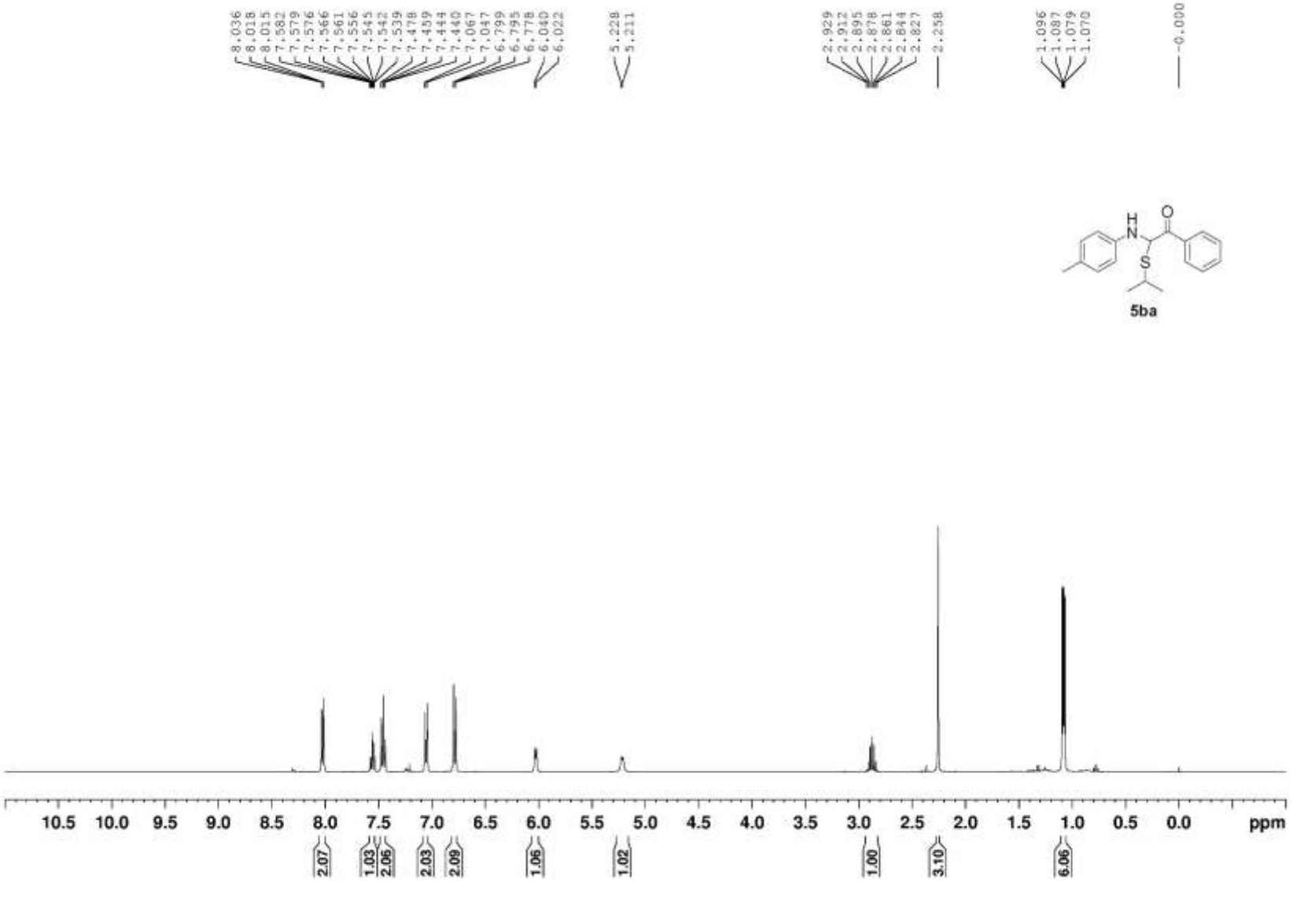

190.00
157.10
145.47
134.41
133.68
129.52
128.73
123.80
121.51
77.32
77.00
76.68
67.26
28.20
28.12
22.34
13.95
O
N
O
3ae
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

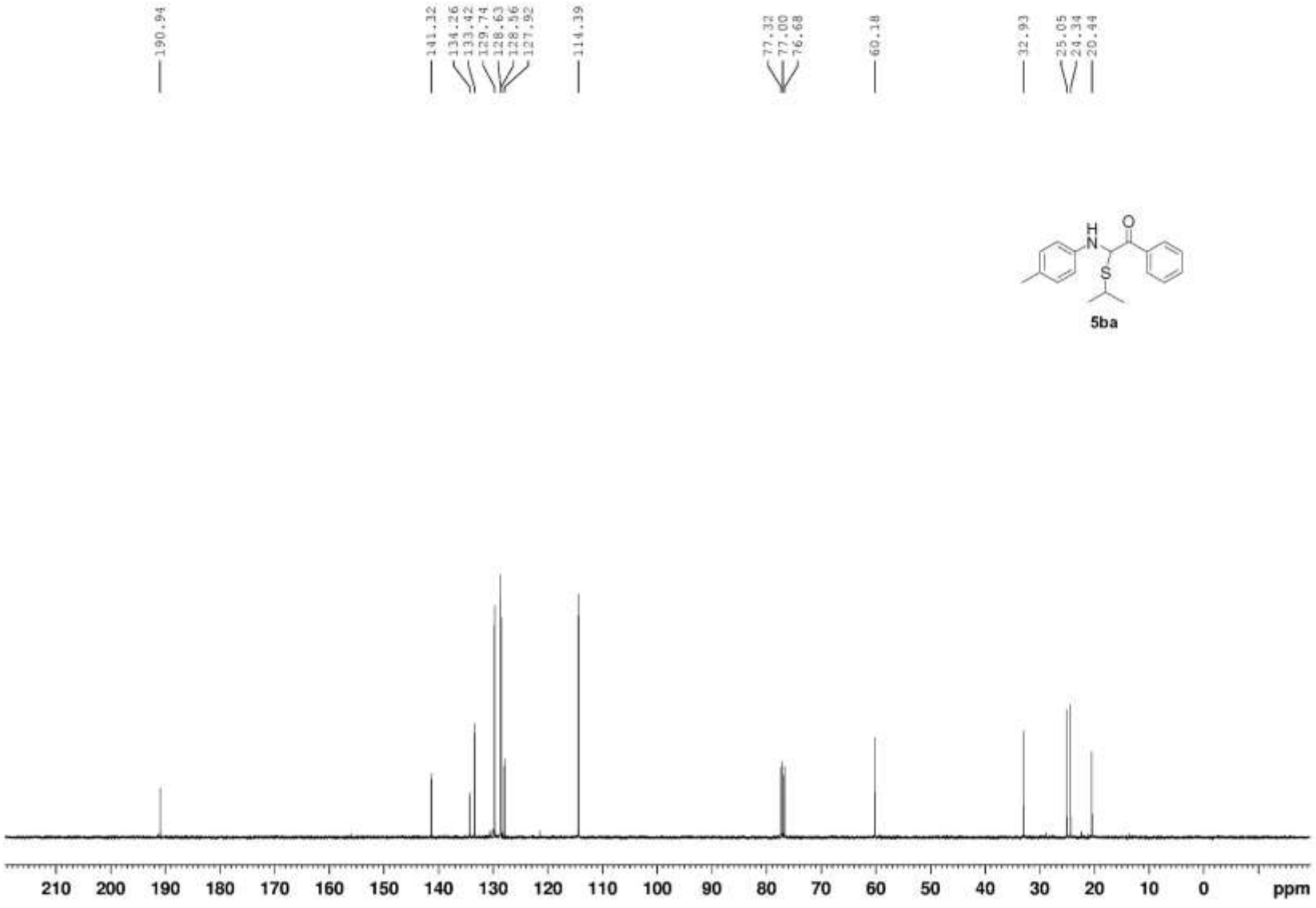

13.43
7.77
7.75
7.50
7.48
7.41
7.38
7.35
7.32
7.25
7.24
7.18
7.16
7.13
7.10
7.07
7.02
7.00
6.97
6.96
6.94
6.81
6.79
6.76
0.01
O
N
OH
1.00
2.23
1.27
3.16
3.36
1.13
1.07
2.31
1.35
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
f1 (ppm)

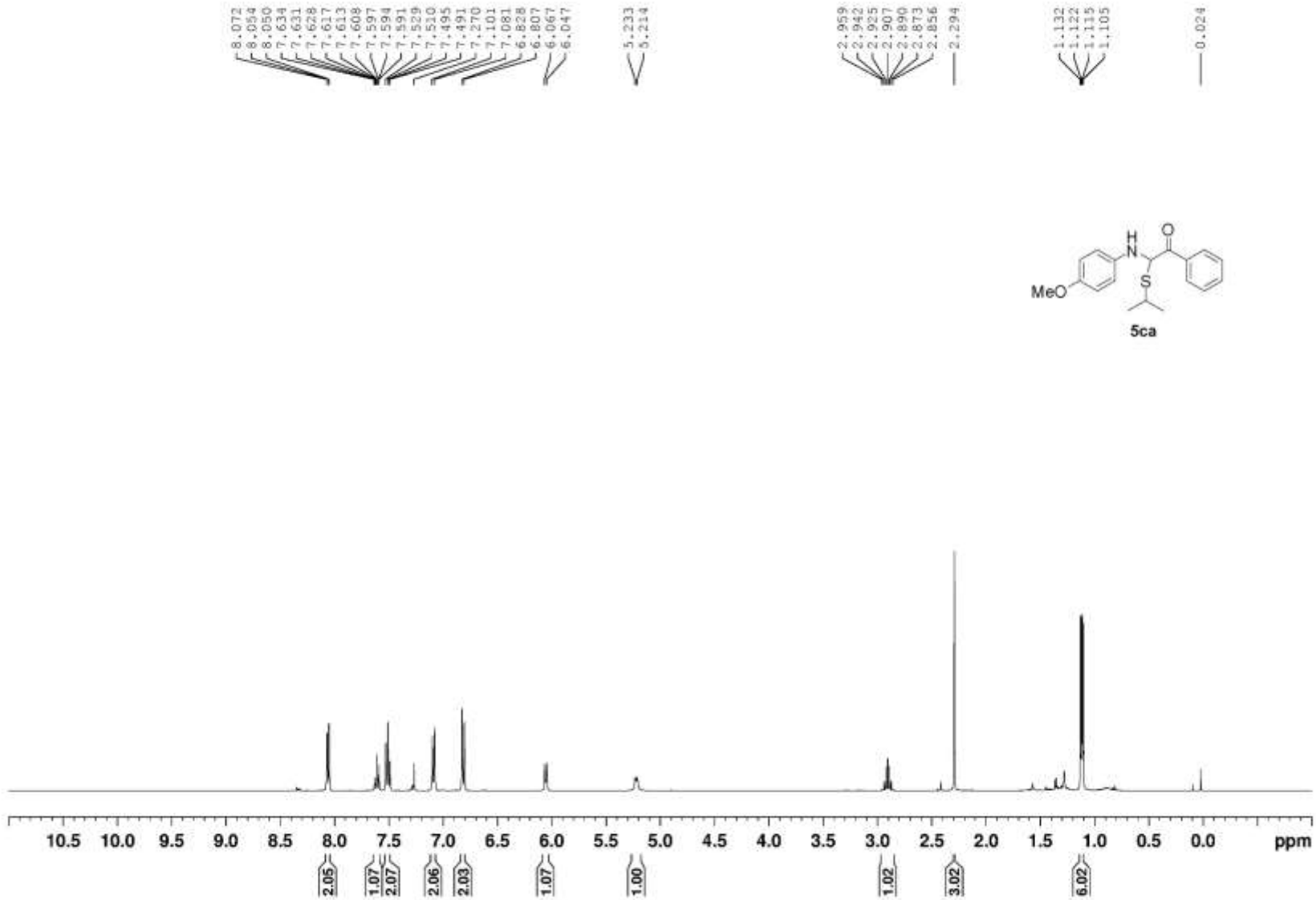
**3ag'**

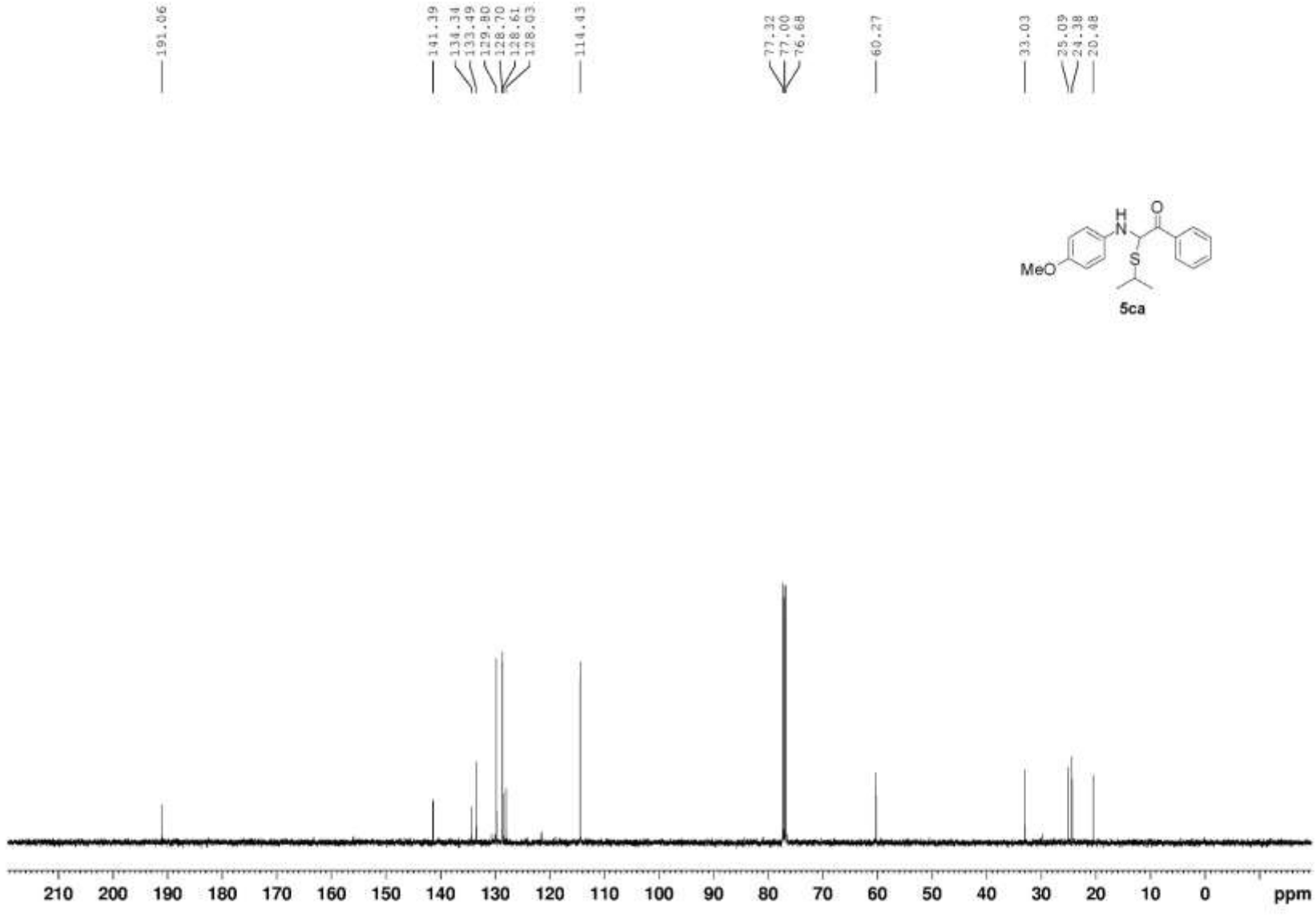

8.076
8.058
8.055
7.637
7.624
7.619
7.614
7.603
7.600
7.597
7.535
7.515
7.497
7.303
7.284
7.281
7.270
7.263
6.918
6.916
6.897
6.895
6.864
6.846
6.827
6.065
5.362
2.970
2.953
2.935
2.918
2.901
2.884
2.867
1.130
1.126
1.113
1.109
0.023
H
N
O
S
5aa
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.20
1.10
2.11
2.16
2.06
1.10
1.08
1.00
1.04
6.10


191.02
143.73
134.22
133.56
129.26
128.72
128.62
118.78
114.33
77.32
77.00
76.68
59.84
33.06
25.06
24.36
5aa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

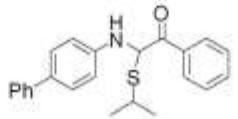

8.036
8.018
8.015
7.582
7.579
7.576
7.566
7.561
7.556
7.545
7.542
7.539
7.478
7.459
7.444
7.440
7.067
7.047
6.799
6.795
6.778
6.040
6.022
5.228
5.211
2.929
2.912
2.895
2.878
2.861
2.844
2.827
2.258
1.096
1.087
1.079
1.070
-0.000
H
N
O
S
5ba
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.07
1.03
2.06
2.03
2.09
1.06
1.02
1.00
3.10
6.06


190.94
141.32
134.26
133.42
129.74
128.63
128.56
127.92
114.39
77.32
77.00
76.68
60.18
32.93
25.05
24.34
20.44
5ba
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

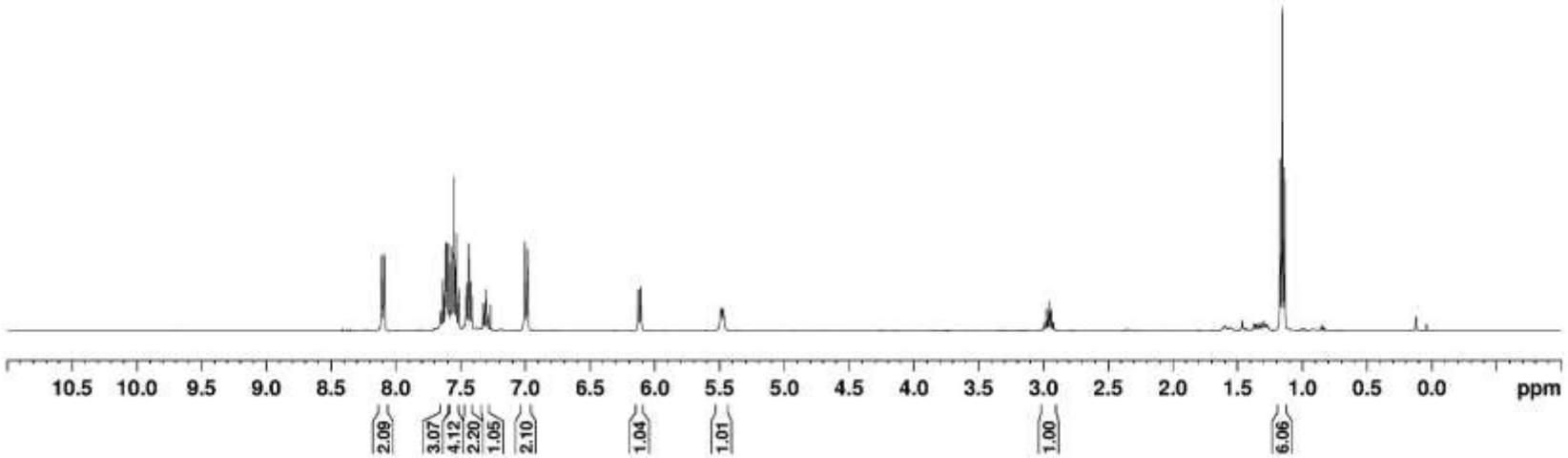

8.072
8.054
8.050
7.634
7.631
7.628
7.617
7.613
7.608
7.597
7.594
7.591
7.529
7.510
7.495
7.491
7.270
7.101
7.081
6.828
6.807
6.067
6.047
5.233
5.214
2.959
2.942
2.925
2.907
2.890
2.873
2.856
2.294
1.132
1.122
1.115
1.105
0.024
MeO
H
N
O
S
5ca
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.05
1.07
2.07
2.06
2.03
1.07
1.00
1.02
3.02
6.02

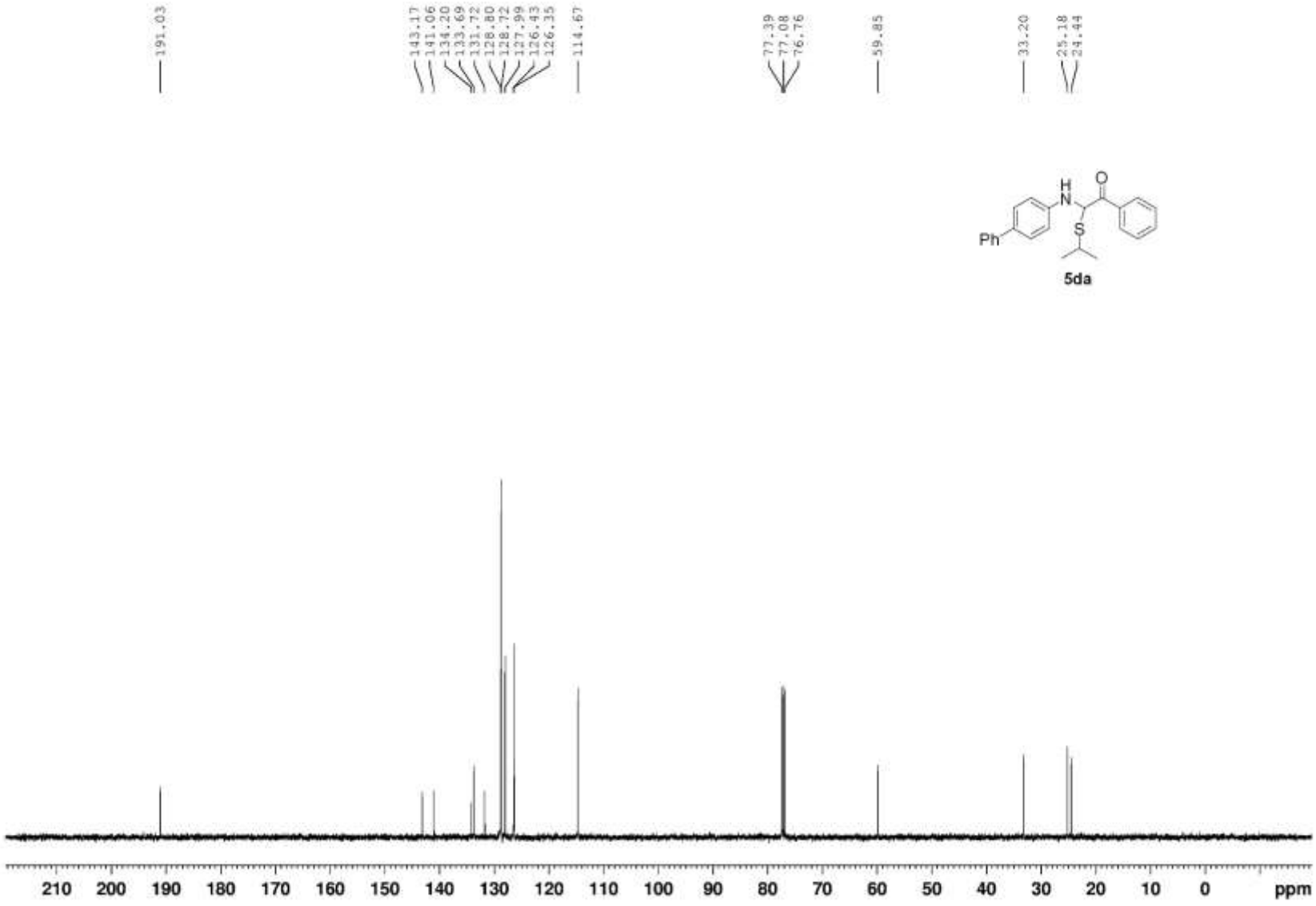

191.06
141.39
134.34
133.49
129.80
128.70
128.61
128.03
114.43
77.32
77.00
76.68
60.27
33.03
25.09
24.38
20.48
MeO
H
N
O
S
5ca
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

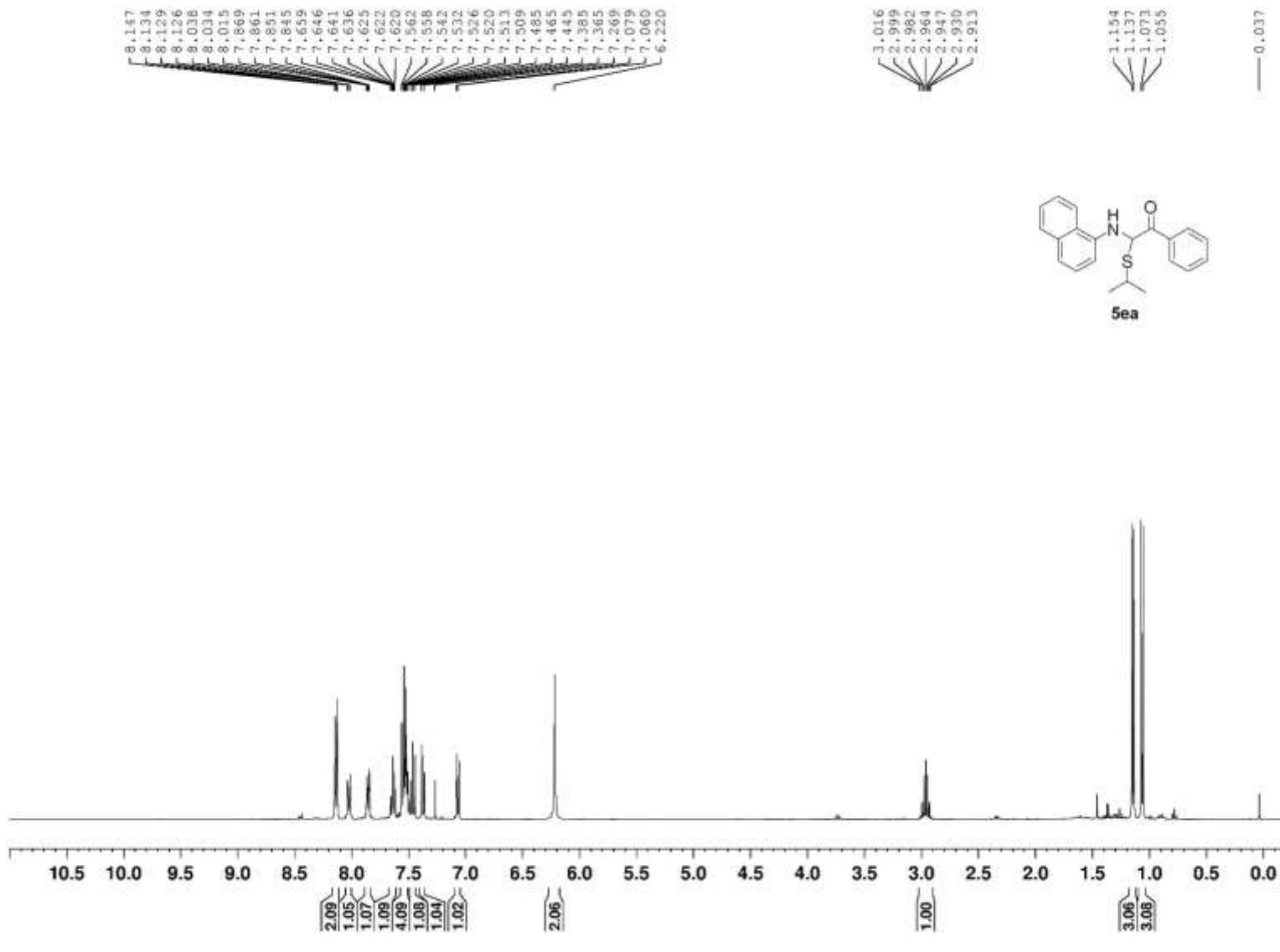

8.110
8.091
7.654
7.652
7.641
7.636
7.617
7.614
7.595
7.574
7.553
7.533
7.515
7.456
7.437
7.418
7.326
7.307
7.289
7.269
7.005
6.984
6.129
6.109
5.491
5.472
3.009
2.992
2.975
2.958
2.941
2.924
2.907
1.173
1.156
1.138
0.043
0.041

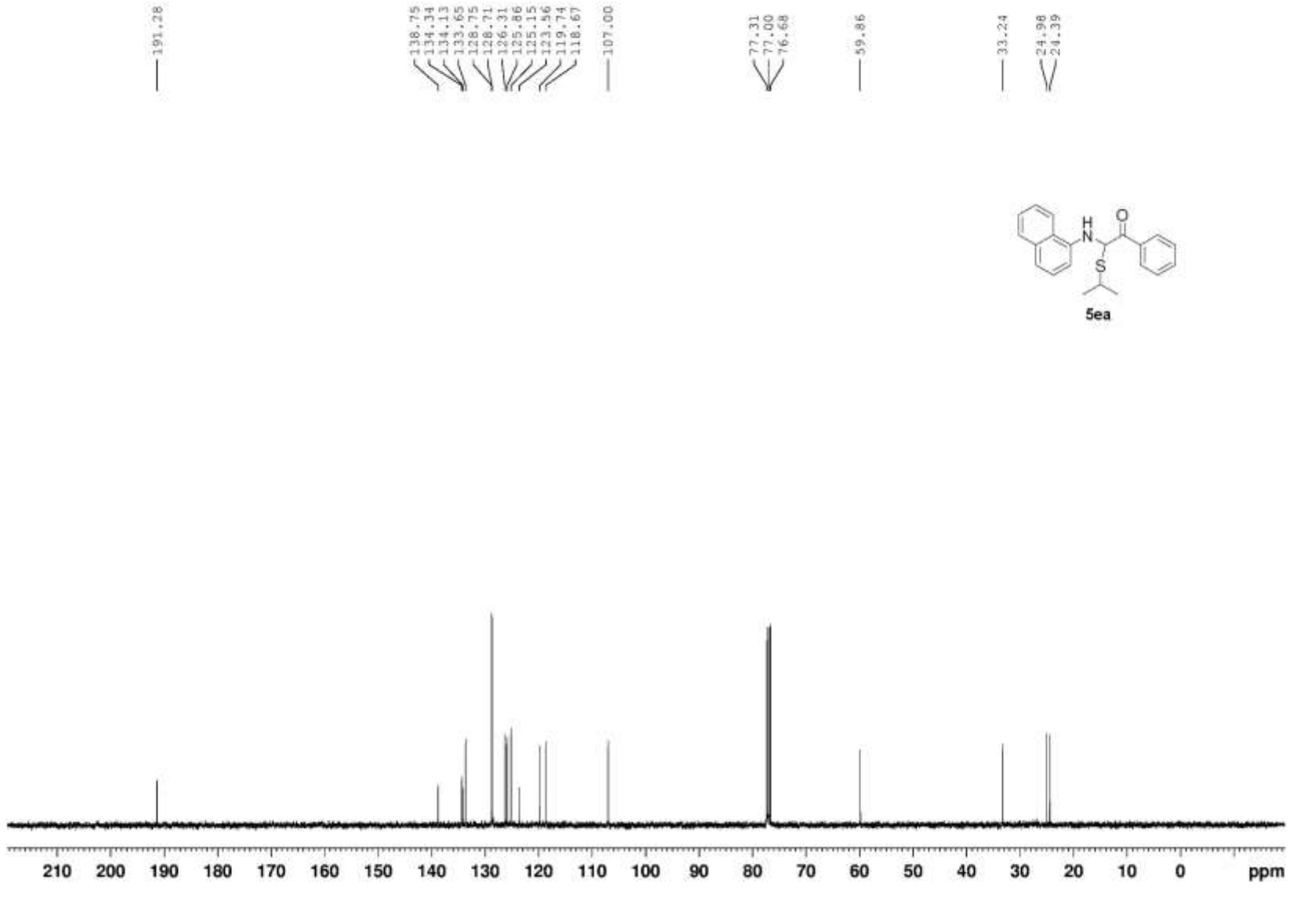

H
N
O
S
Ph

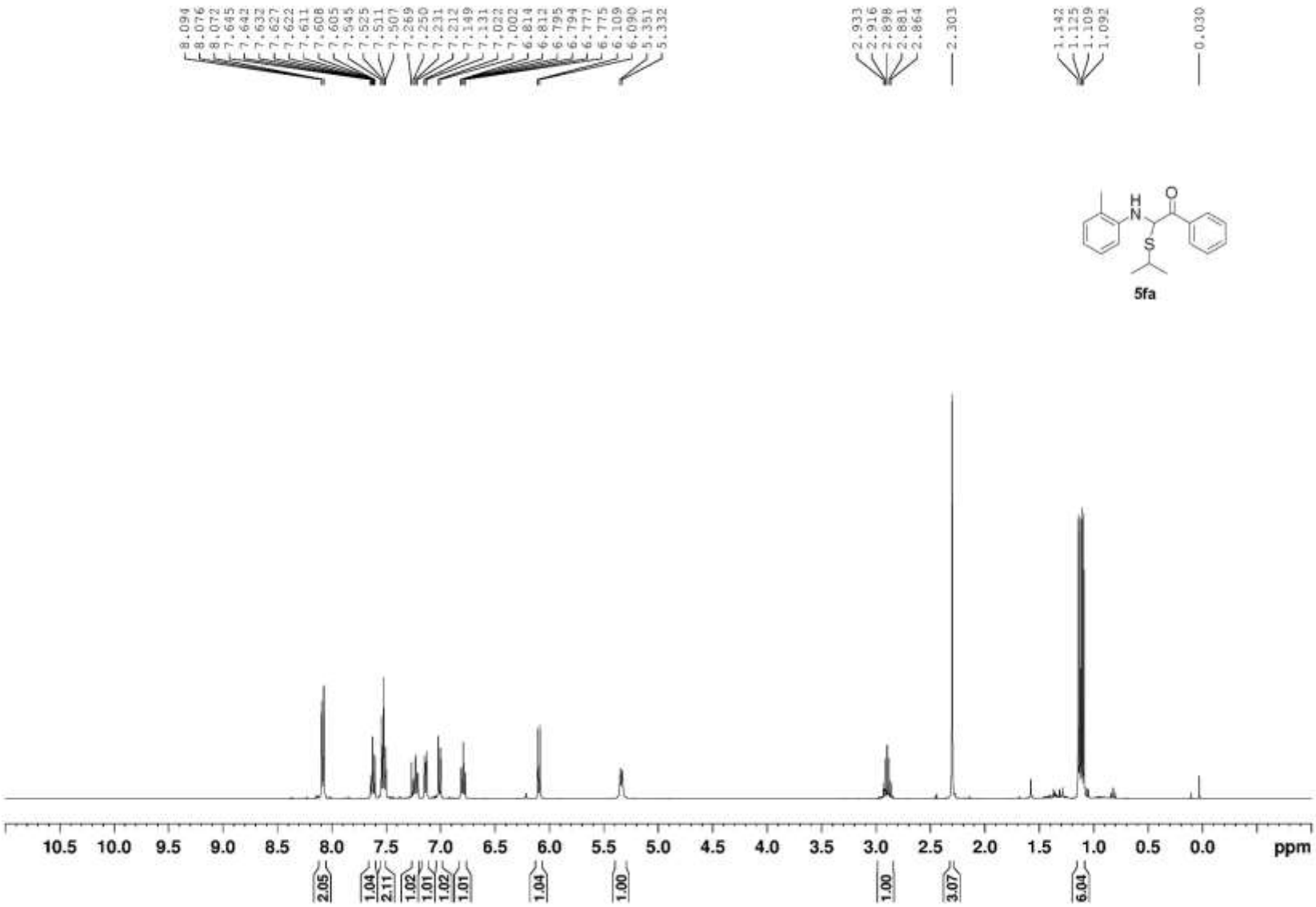
5da

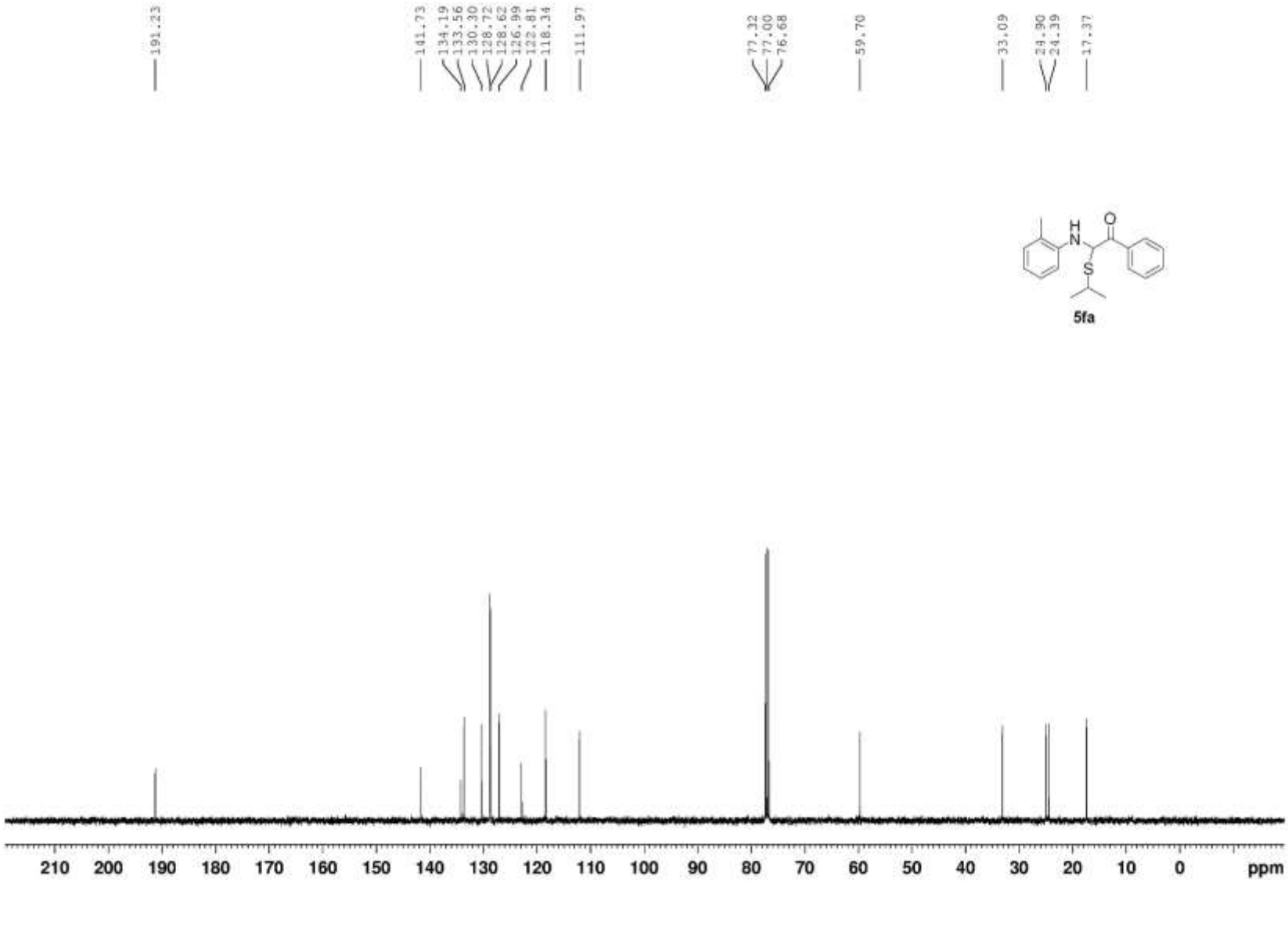

10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.09
3.07
4.12
2.20
1.05
2.10
1.04
1.01
1.00
6.06

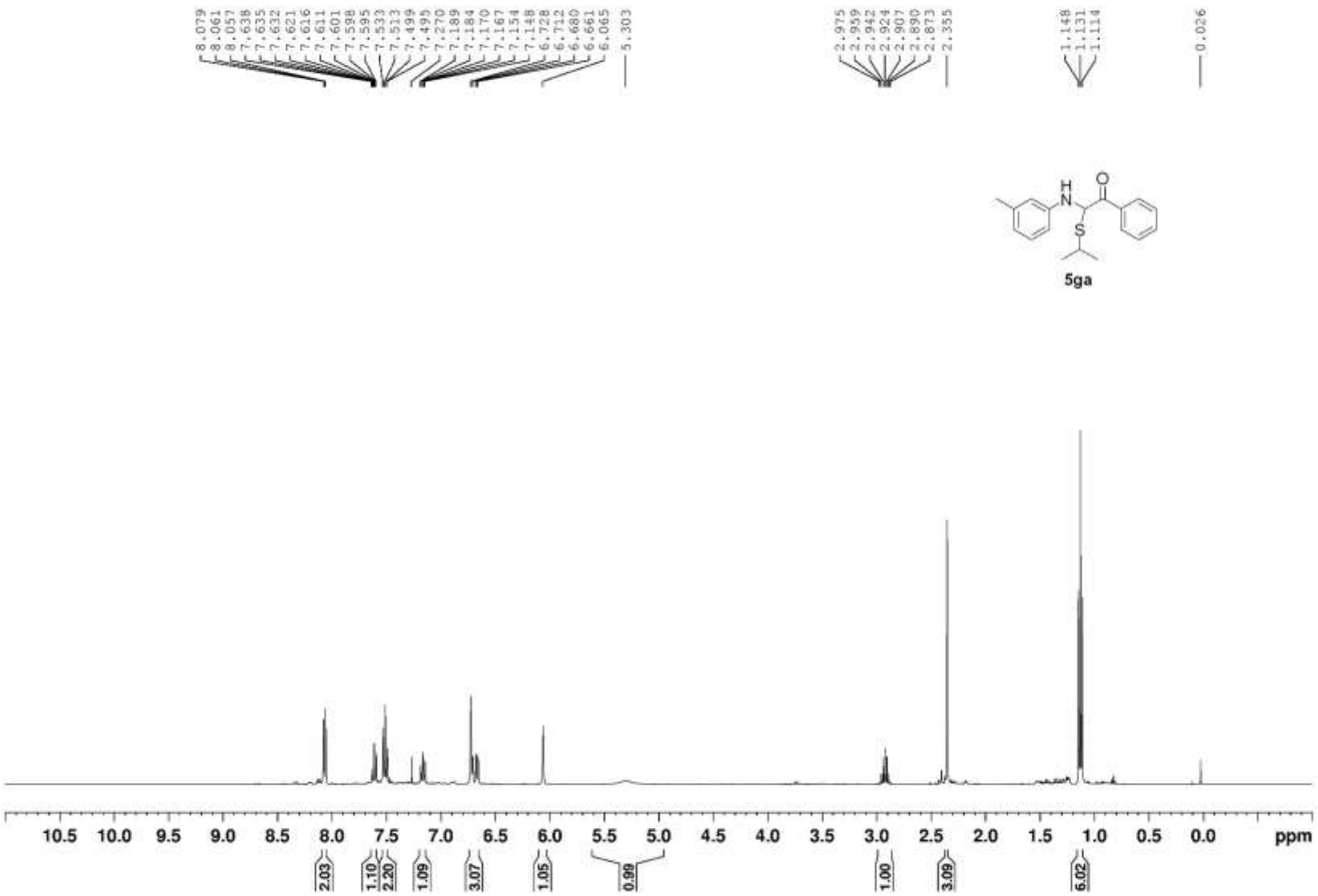

191.03
143.17
141.06
134.20
133.69
131.72
128.80
128.72
127.99
126.43
126.35
114.67
77.39
77.08
76.76
59.85
33.20
25.18
24.44
H
N
O
S
Ph
5da
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

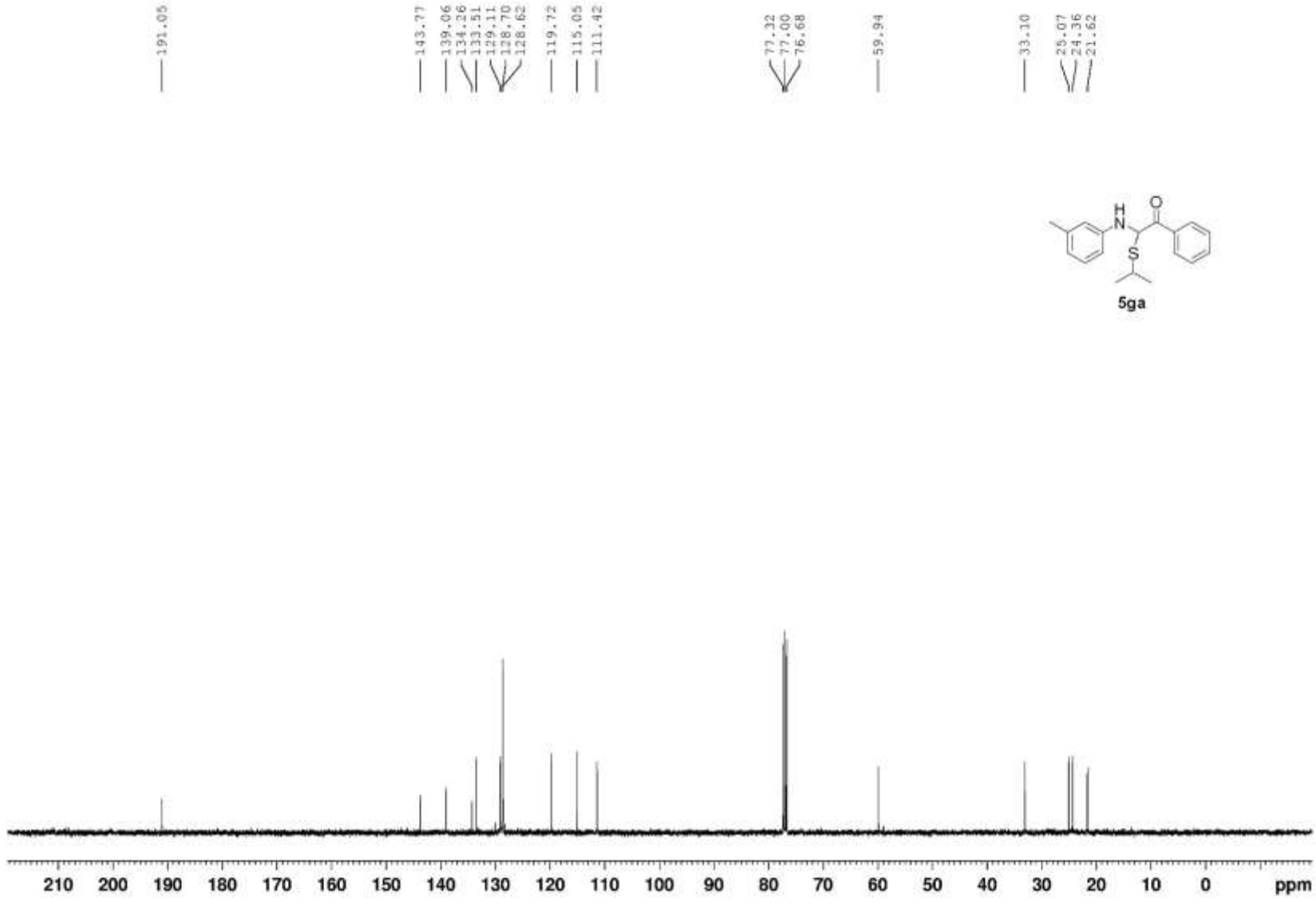

8.167
8.134
8.129
8.126
8.038
8.034
8.015
7.869
7.861
7.851
7.845
7.659
7.646
7.641
7.636
7.625
7.622
7.620
7.562
7.558
7.542
7.532
7.526
7.520
7.513
7.509
7.485
7.465
7.445
7.385
7.365
7.269
7.079
7.060
6.220
3.016
2.999
2.982
2.964
2.947
2.930
2.913
1.154
1.137
1.073
1.055
0.037
H
N
O
S
5ea
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.09
1.05
1.07
1.09
4.09
1.08
1.04
1.02
2.06
1.00
3.06
3.08

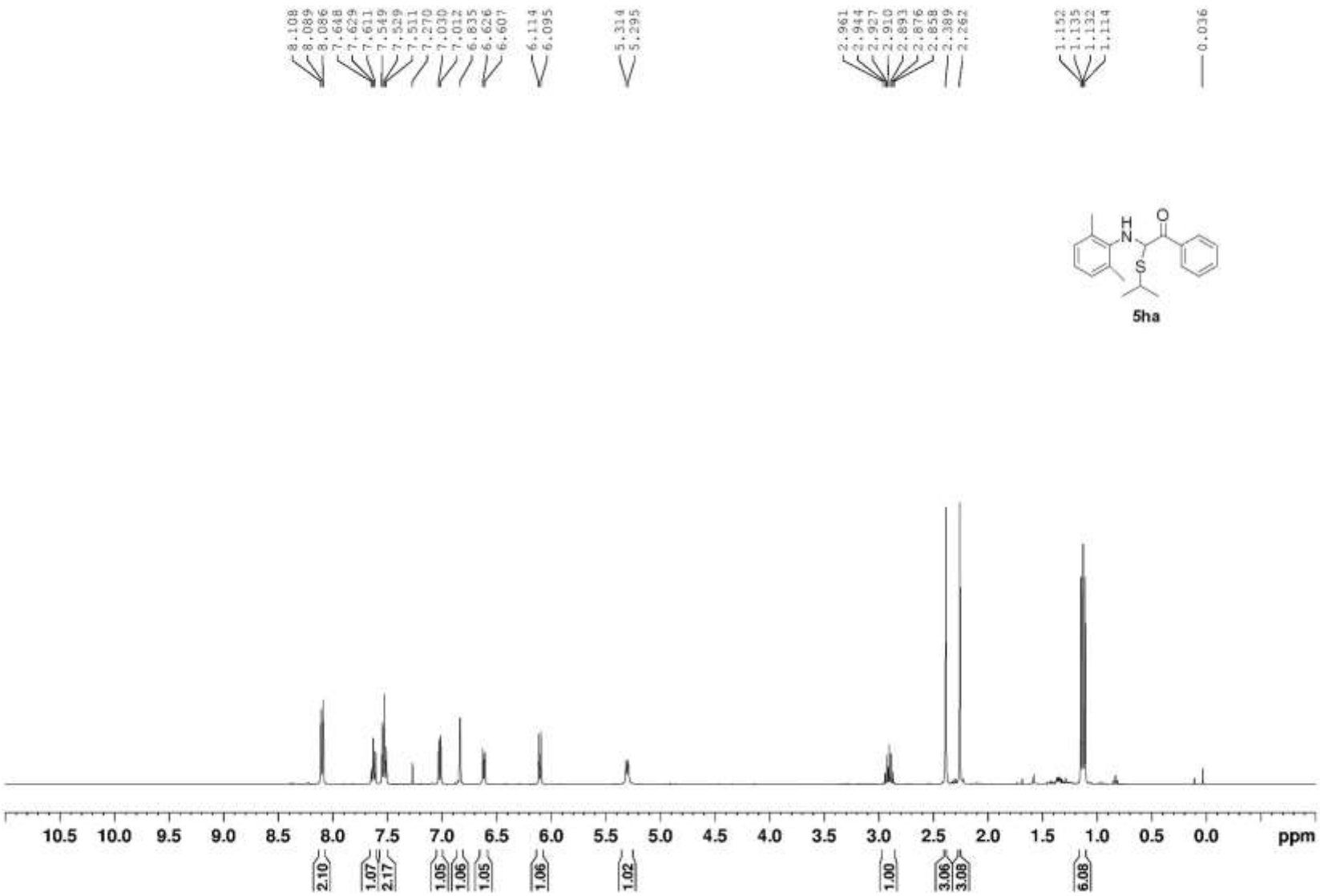

191.28
138.75
134.34
134.13
133.65
128.75
128.71
126.31
125.86
125.15
123.56
119.74
118.67
107.00
77.31
77.00
76.68
59.86
33.24
24.98
24.39
H
N
O
S
5ea
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

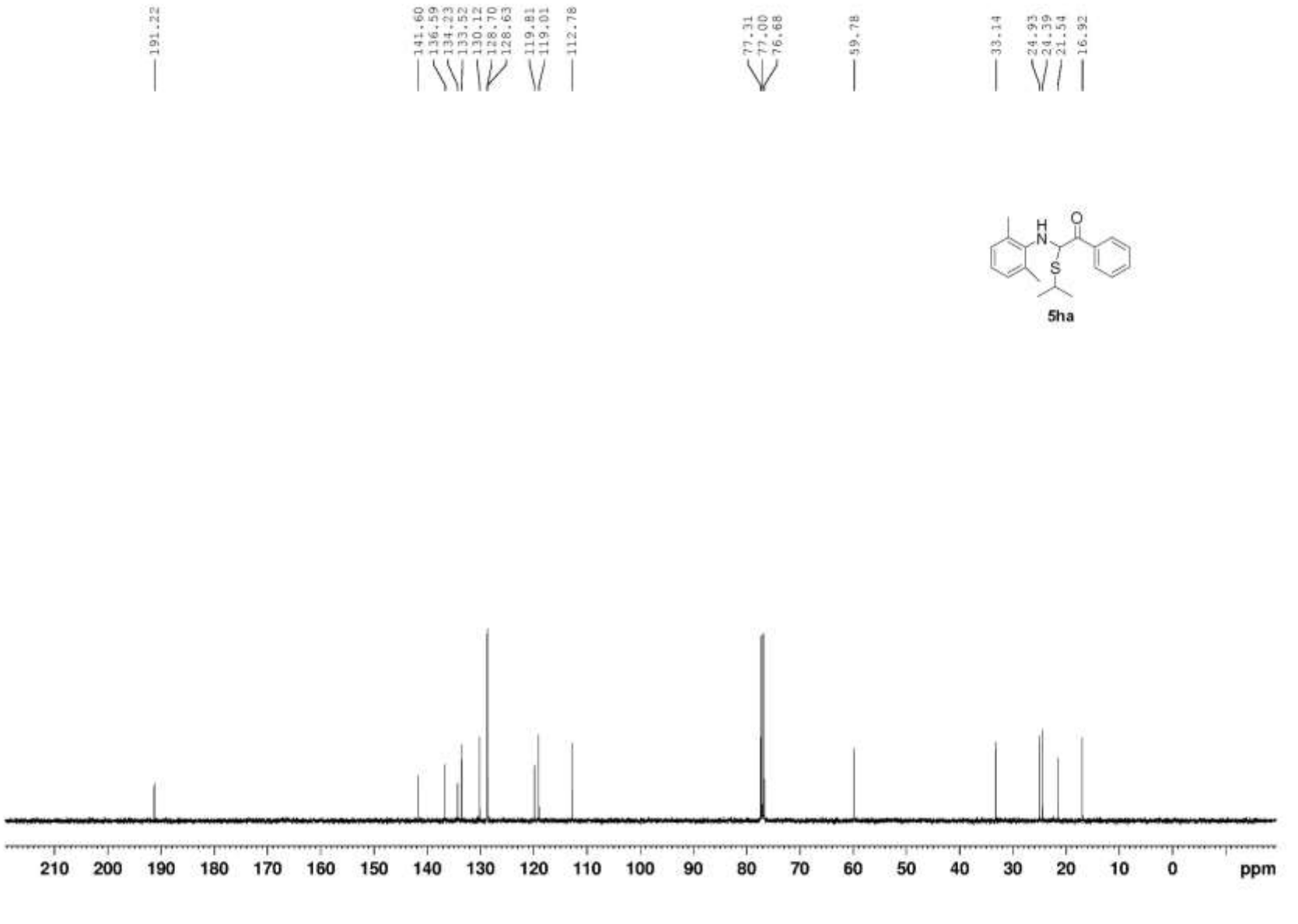

8.094
8.076
8.072
7.645
7.642
7.632
7.627
7.622
7.611
7.608
7.605
7.545
7.525
7.511
7.507
7.269
7.250
7.231
7.212
7.149
7.131
7.022
7.002
6.814
6.812
6.795
6.794
6.777
6.775
6.109
6.090
5.351
5.332
2.933
2.916
2.898
2.881
2.864
2.303
1.142
1.125
1.109
1.092
0.030
H
N
O
S
5fa
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.05
1.04
2.11
1.02
1.01
1.02
1.01
1.04
1.00
1.00
3.07
6.04

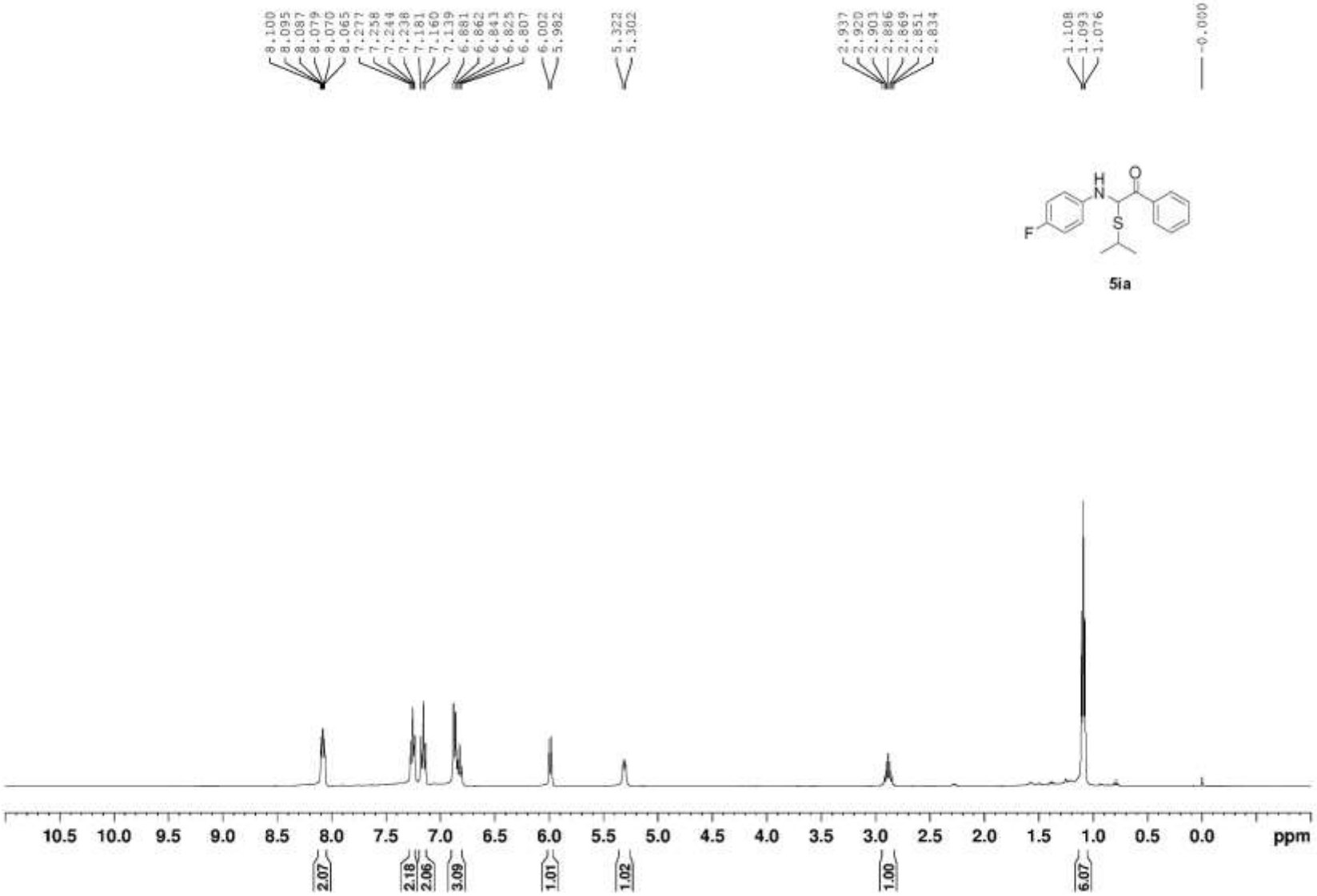

191.23
141.73
134.19
133.56
130.30
128.72
128.62
126.99
122.81
118.34
111.97
77.32
77.00
76.68
59.70
33.09
24.90
24.39
17.37
5fa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

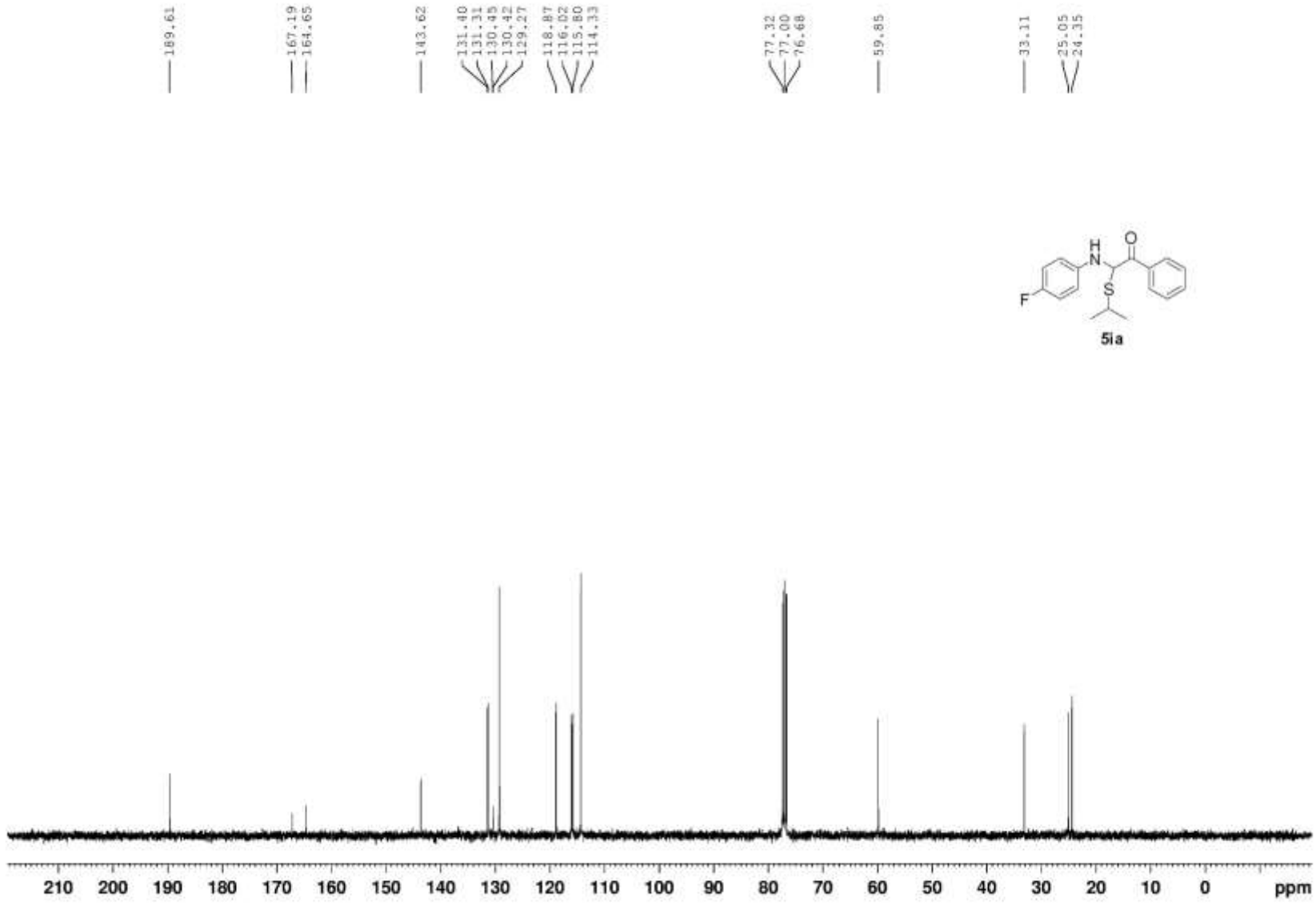

8.079
8.061
8.057
7.638
7.635
7.632
7.621
7.616
7.611
7.601
7.598
7.595
7.533
7.513
7.499
7.495
7.270
7.189
7.184
7.170
7.167
7.154
7.148
6.728
6.712
6.680
6.661
6.065
5.303
2.975
2.959
2.942
2.924
2.907
2.890
2.873
2.355
1.148
1.131
1.114
0.026
H
N
O
S
5ga
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.03
1.10
2.20
1.09
3.07
1.05
0.99
1.00
3.09
6.02

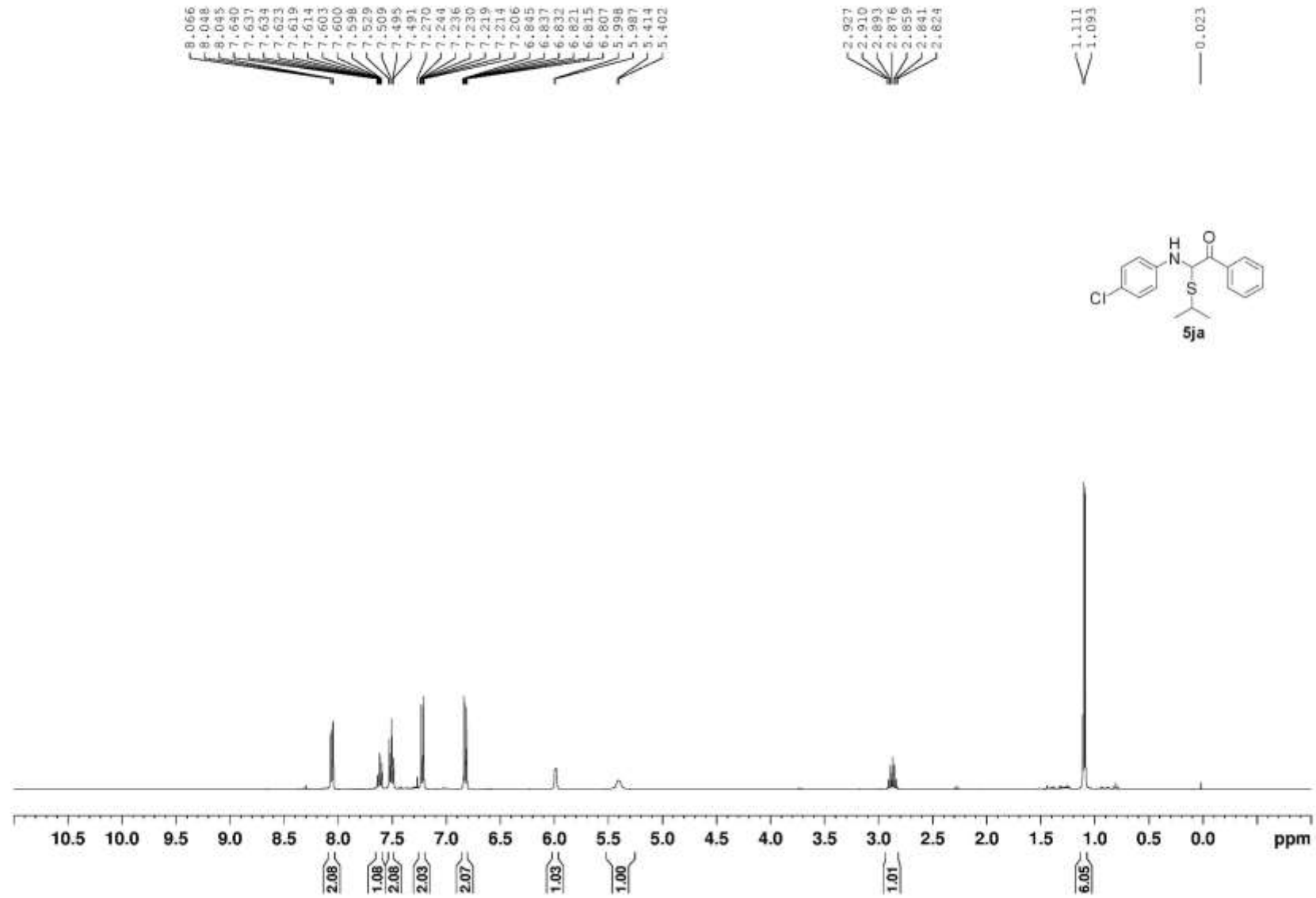

191.05
143.77
139.06
134.26
133.51
129.11
128.70
128.62
119.72
115.05
111.42
77.32
77.00
76.68
59.94
33.10
25.07
24.36
21.62
5ga
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

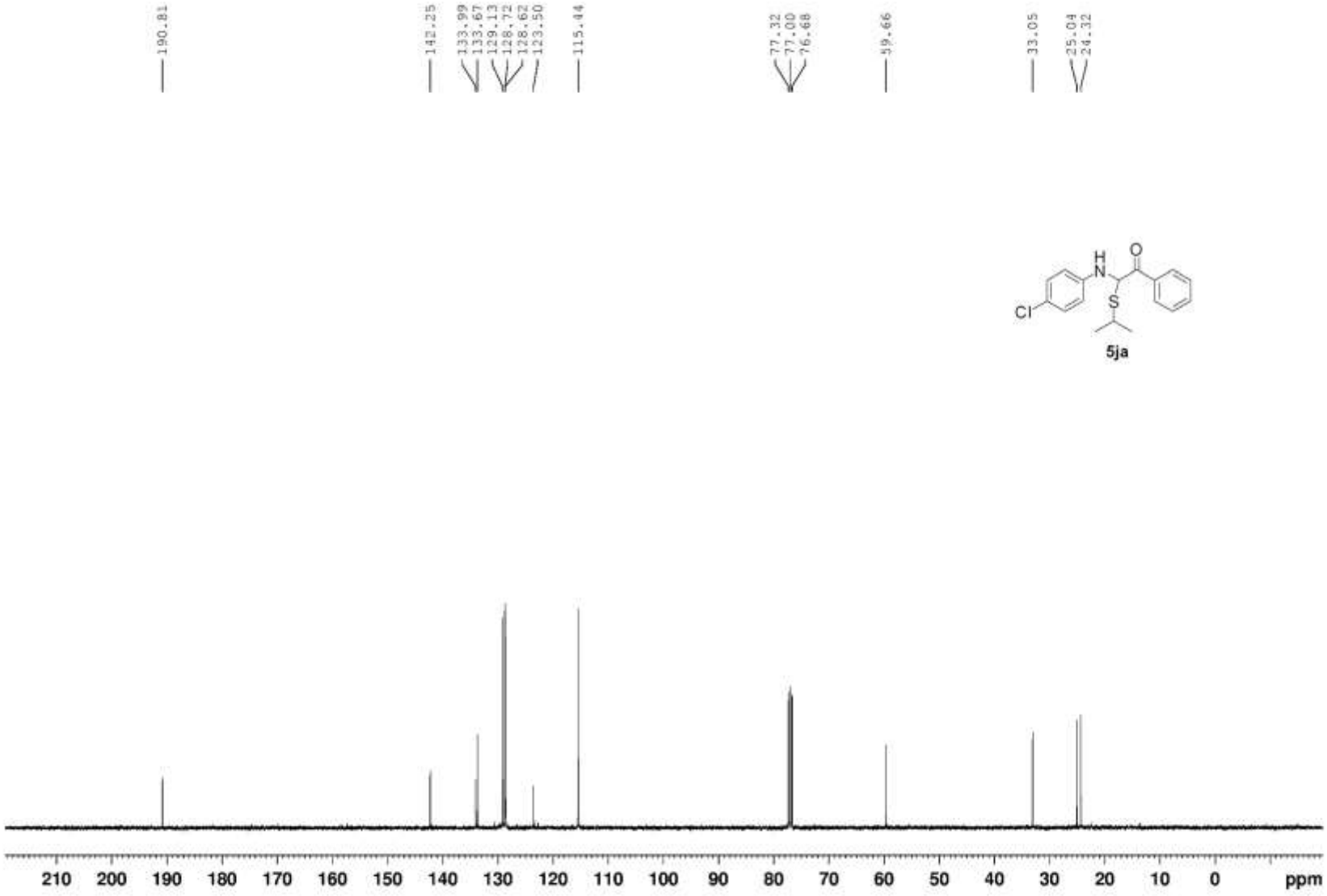

8.108
8.089
8.086
7.648
7.629
7.611
7.549
7.529
7.511
7.270
7.030
7.012
6.835
6.626
6.607
6.114
6.095
5.314
5.295
2.961
2.944
2.927
2.910
2.893
2.876
2.858
2.389
2.262
1.152
1.135
1.132
1.114
0.036
5ha
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.10
1.07
2.17
1.05
1.06
1.05
1.06
1.02
1.00
3.06
3.08
6.08

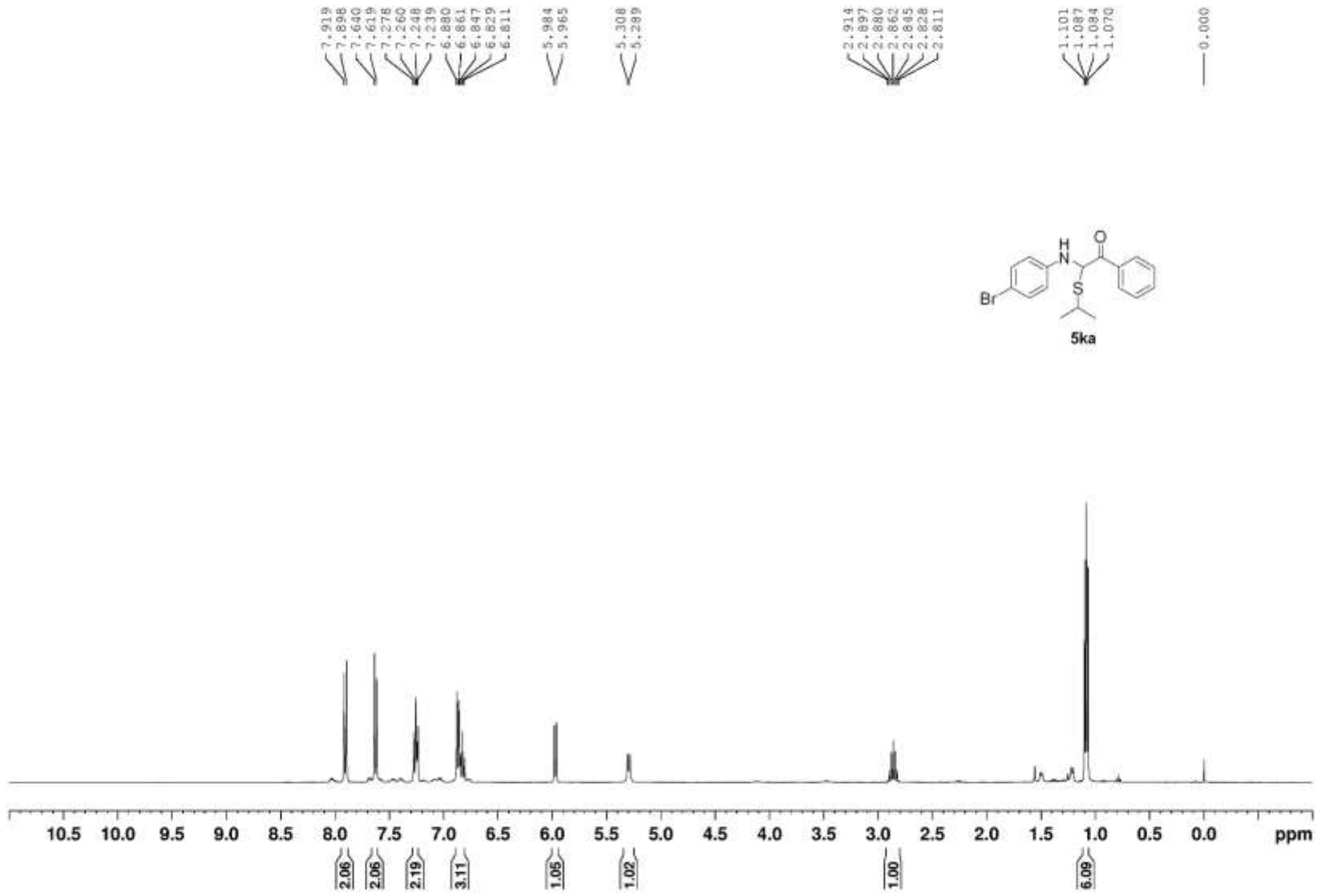

191.22
141.60
136.59
134.23
133.52
130.12
128.70
128.63
119.81
119.01
112.78
77.31
77.00
76.68
59.78
33.14
24.93
24.39
21.54
16.92
H
N
O
S
5ha
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

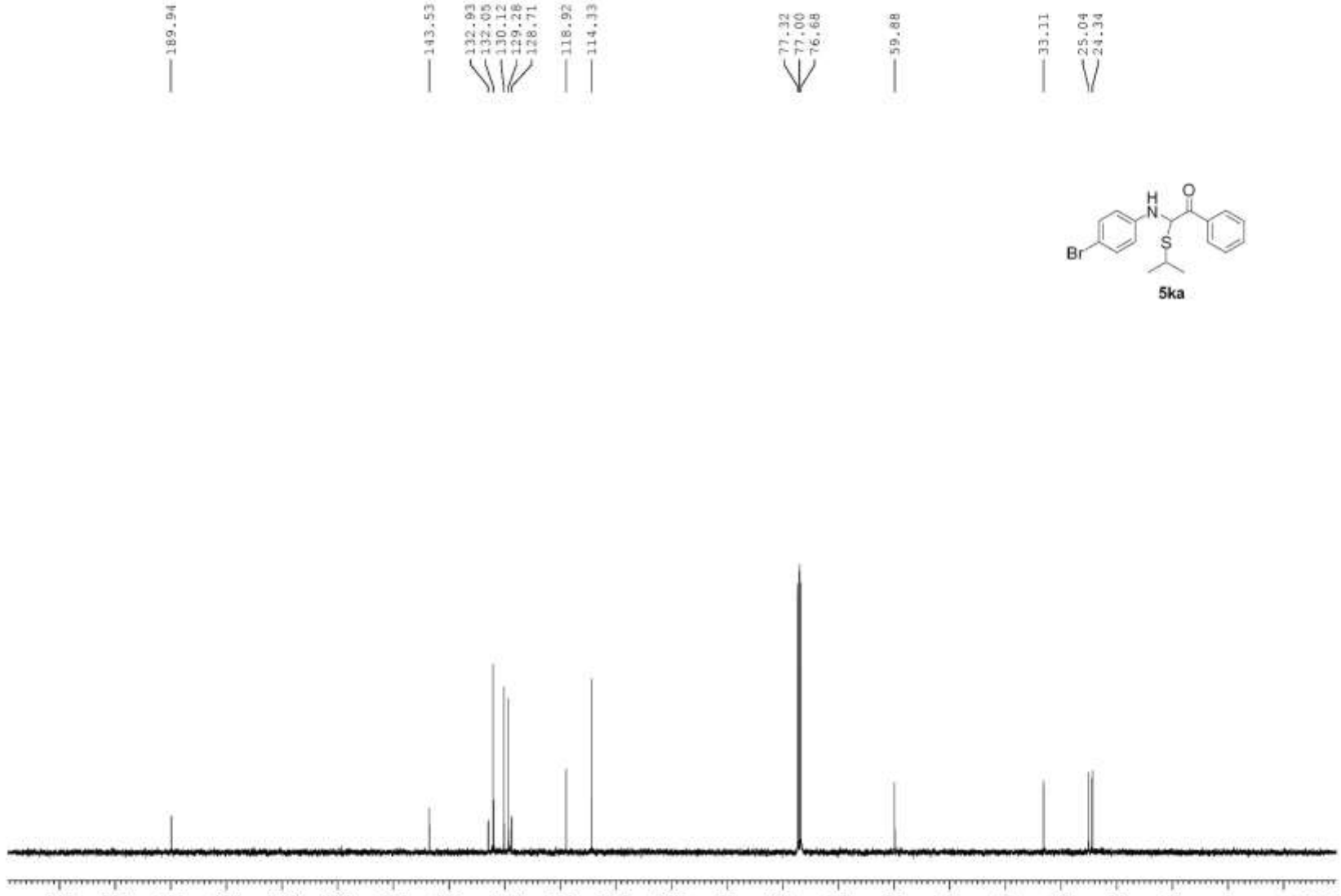

8.100
8.095
8.087
8.079
8.070
8.065
7.277
7.258
7.244
7.238
7.181
7.160
7.139
6.881
6.862
6.843
6.825
6.807
6.002
5.982
5.322
5.302
2.937
2.920
2.903
2.886
2.869
2.851
2.834
1.108
1.093
1.076
-0.000
H
N
O
S
F
5ia
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.07
2.18
2.06
3.09
1.01
1.02
1.00
6.07

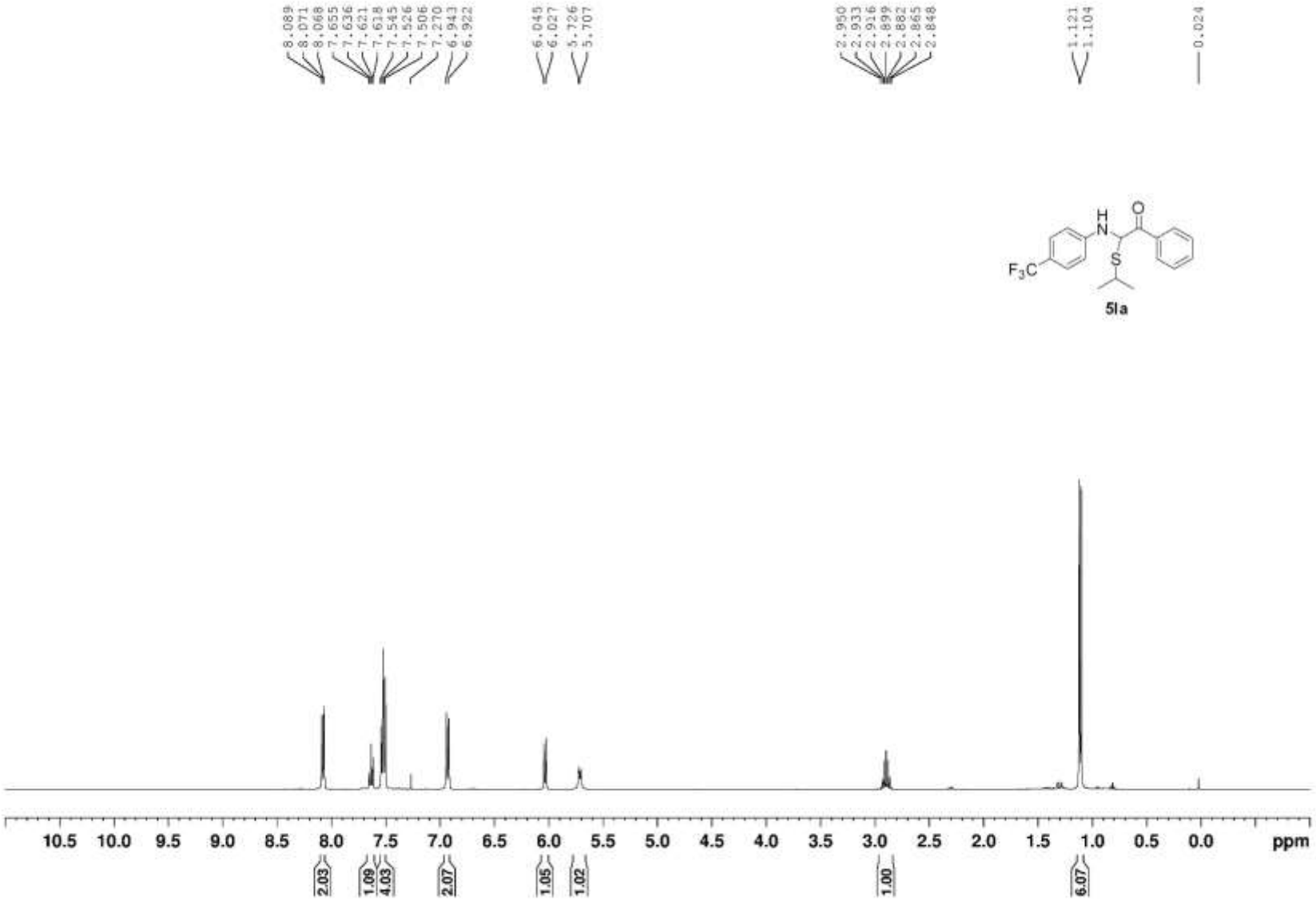

189.61
167.19
164.65
143.62
131.40
131.31
130.45
130.42
129.27
118.87
116.02
115.80
114.33
77.32
77.00
76.68
59.85
33.11
25.05
24.35
F
N
H
O
S
5ia
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

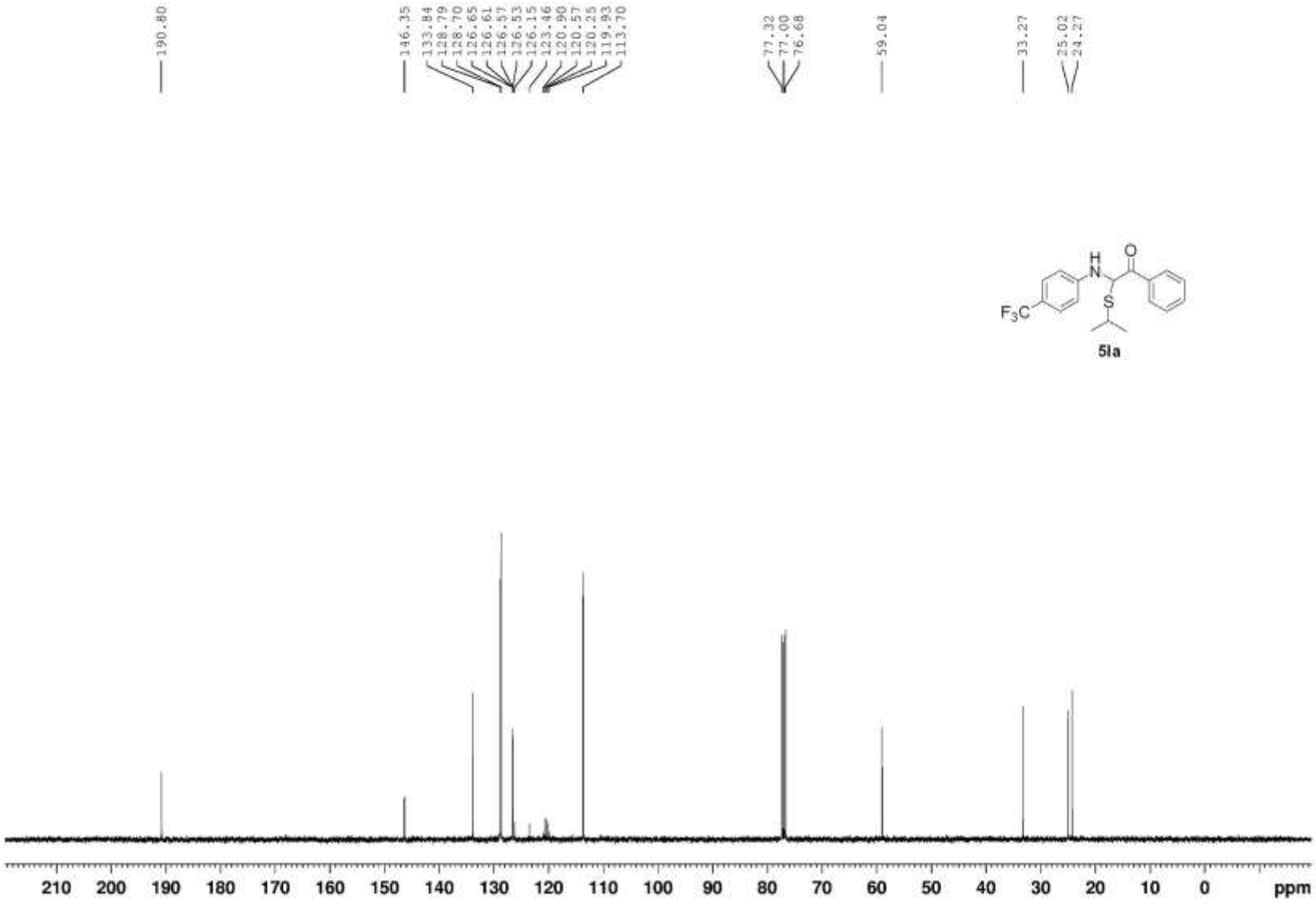

8.066
8.048
8.045
7.640
7.637
7.634
7.623
7.619
7.614
7.603
7.600
7.598
7.529
7.509
7.495
7.491
7.270
7.244
7.236
7.230
7.219
7.214
7.206
6.845
6.837
6.832
6.821
6.815
6.807
5.998
5.987
5.414
5.402
2.927
2.910
2.893
2.876
2.859
2.841
2.824
1.111
1.093
0.023
Cl
H
N
O
S
5ja
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.08
1.08
2.08
2.03
2.07
1.03
1.00
1.01
6.05

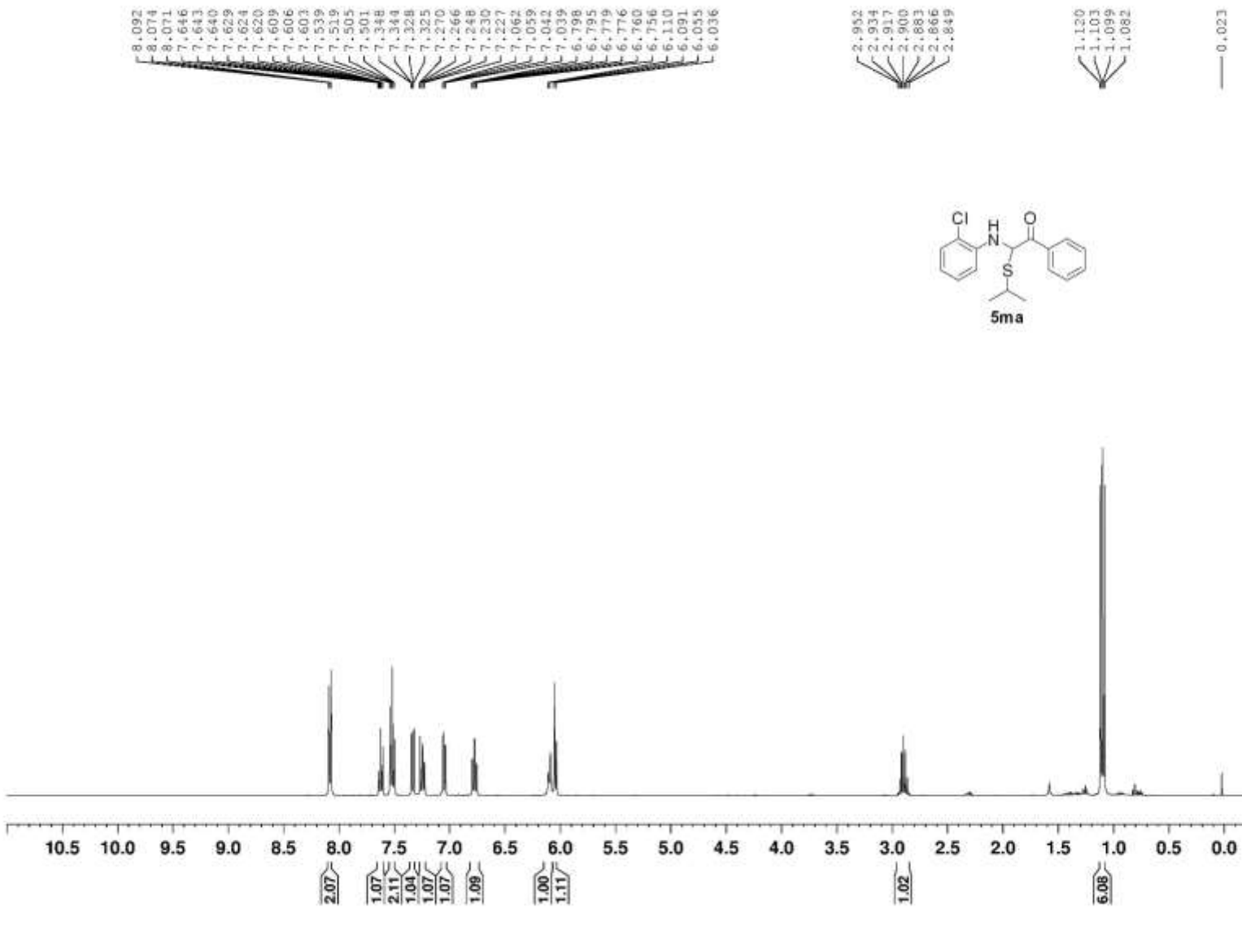

190.81
142.25
133.99
133.67
129.13
128.72
128.62
123.50
115.44
77.32
77.00
76.68
59.66
33.05
25.04
24.32
H
N
O
S
Cl
5ja
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

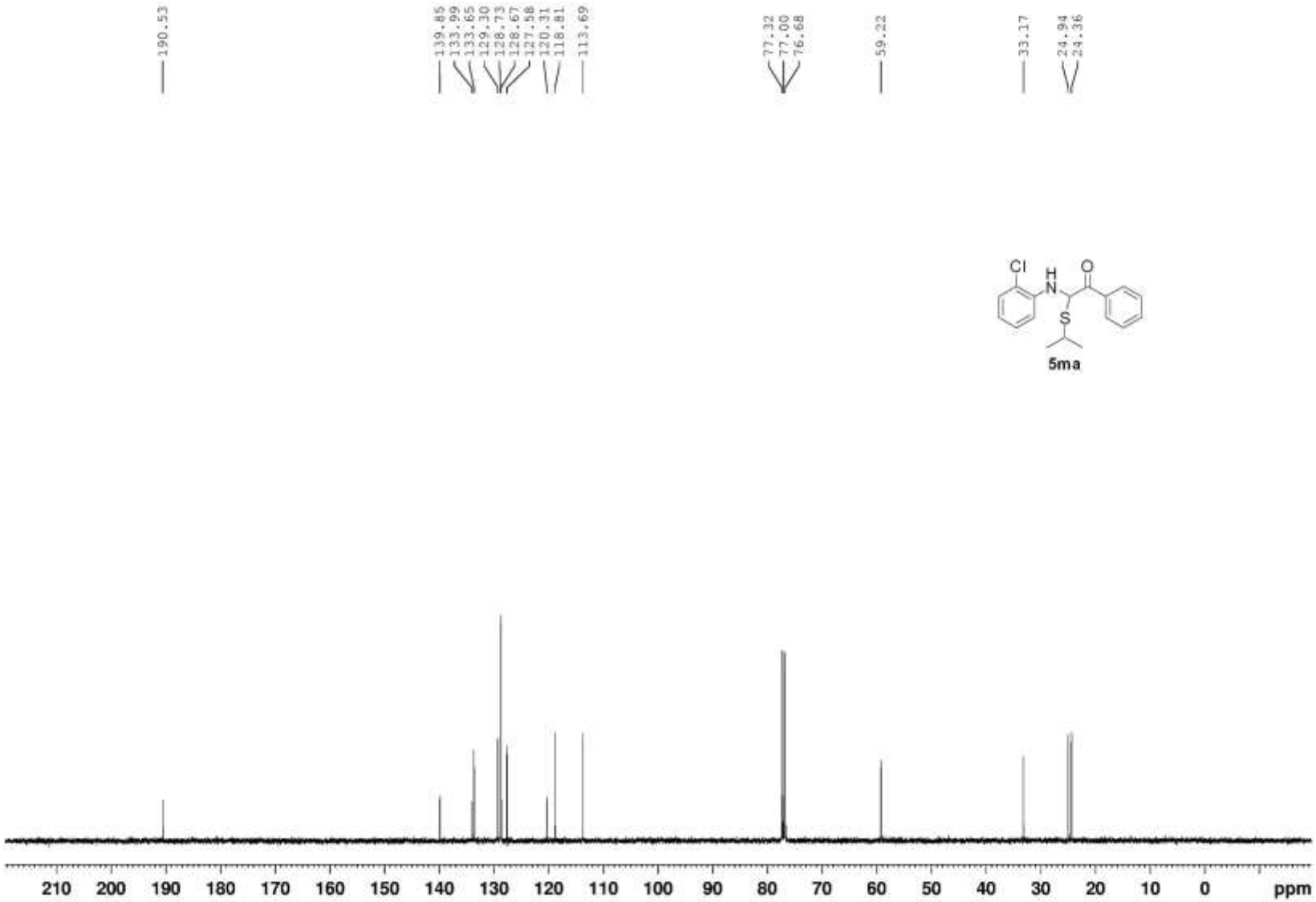

7.919
7.898
7.640
7.619
7.278
7.260
7.248
7.239
6.880
6.861
6.847
6.829
6.811
5.984
5.965
5.308
5.289
2.914
2.897
2.880
2.862
2.845
2.828
2.811
1.101
1.087
1.084
1.070
0.000
H
N
O
S
Br
5ka
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.06
2.06
2.19
3.11
1.05
1.02
1.00
6.09

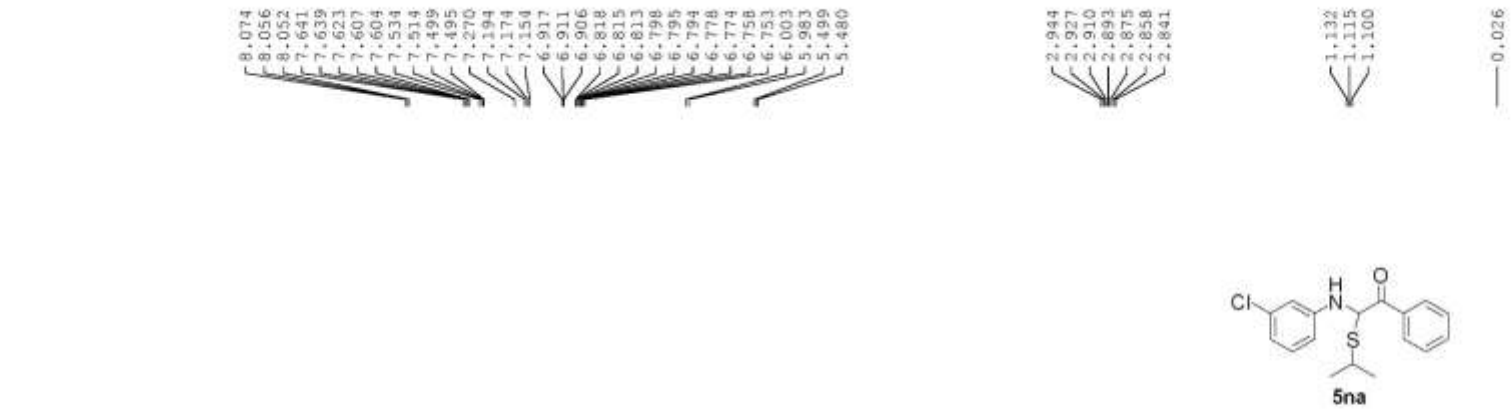

189.94
143.53
132.93
132.05
130.12
129.28
128.71
118.92
114.33
77.32
77.00
76.68
59.88
33.11
25.04
24.34
H
N
O
S
Br
5ka
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

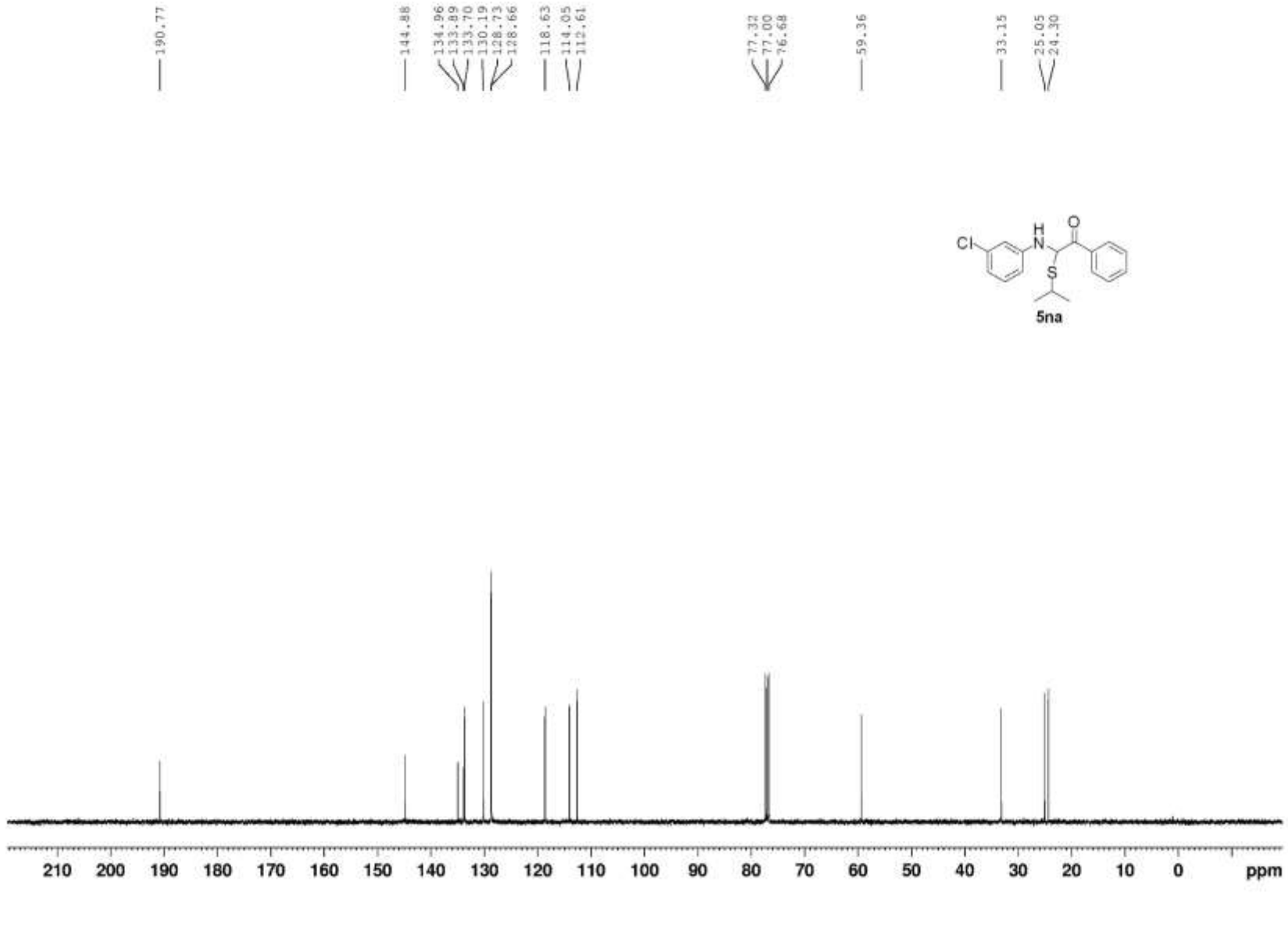

8.089
8.071
8.068
7.655
7.636
7.621
7.618
7.545
7.526
7.506
7.270
6.943
6.922
6.045
6.027
5.726
5.707
2.950
2.933
2.916
2.899
2.882
2.865
2.848
1.121
1.104
0.024
H
N
O
S
F3C
5la
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.03
1.09
4.03
2.07
1.05
1.02
1.00
6.07

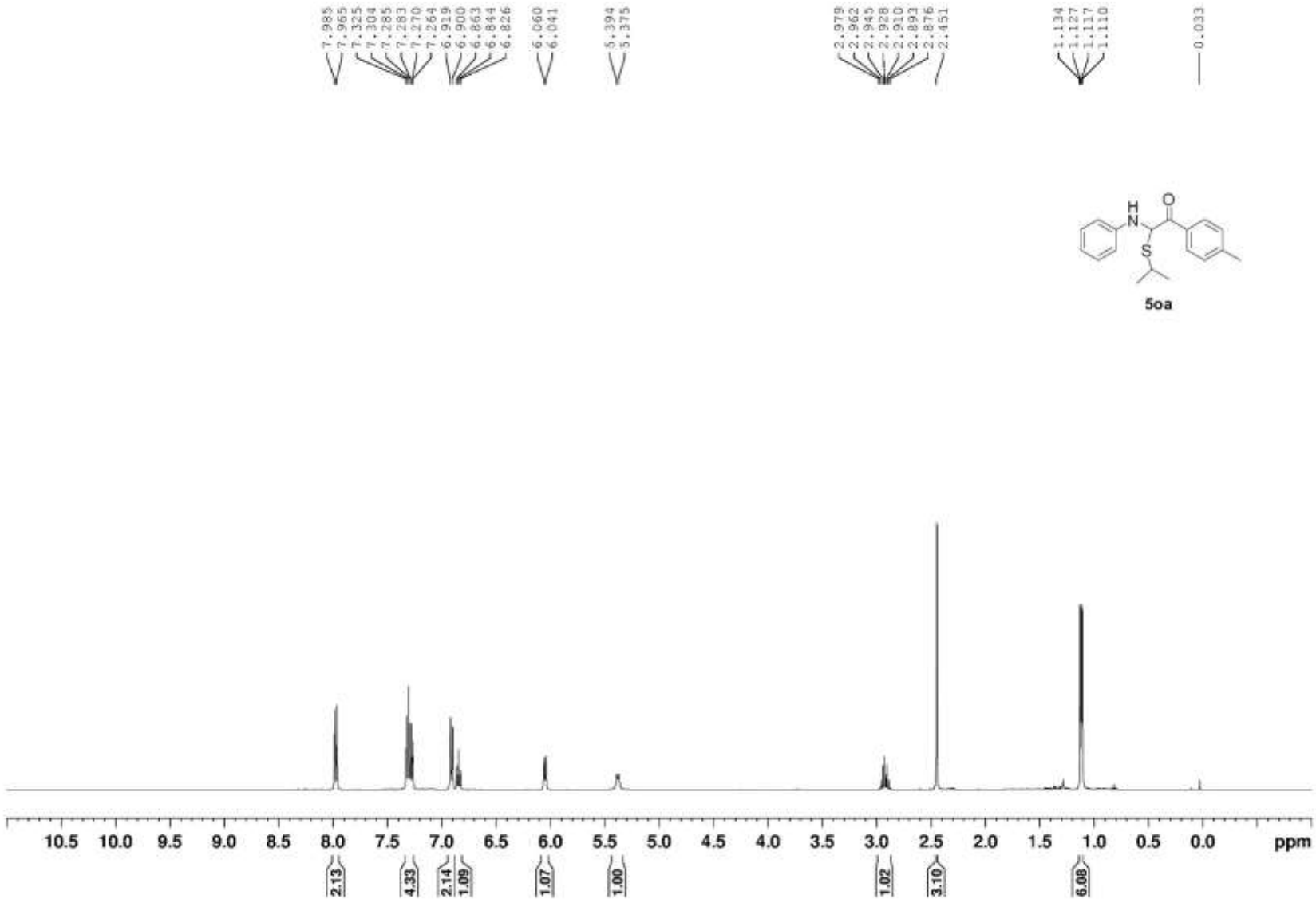

190.80
146.35
133.84
128.79
128.70
126.65
126.61
126.57
126.53
126.15
123.46
120.90
120.57
120.25
119.93
113.70
77.32
77.00
76.68
59.04
33.27
25.02
24.27
H
N
O
S
F3C
5la
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

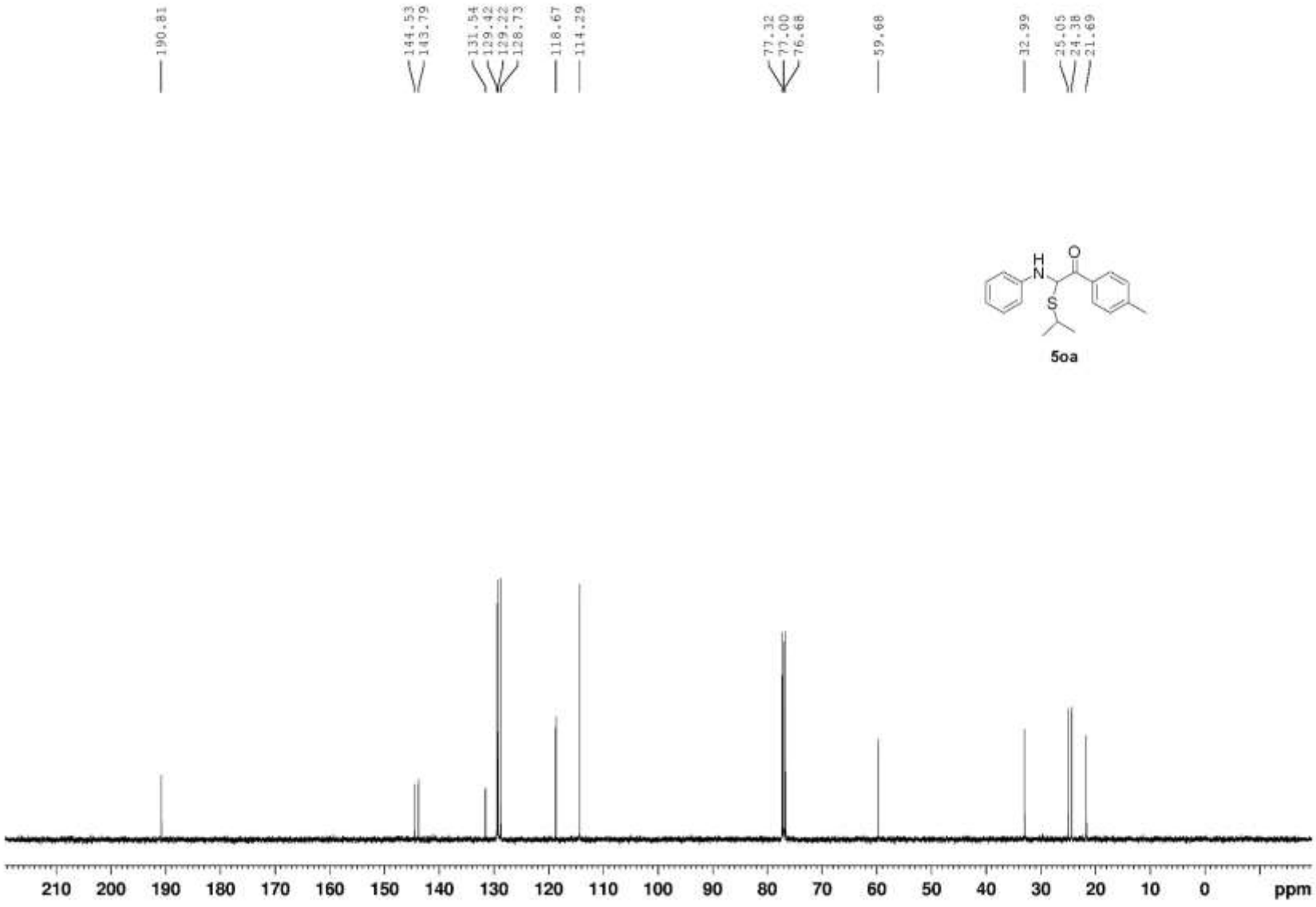

8.092
8.074
8.071
7.646
7.643
7.640
7.629
7.624
7.620
7.609
7.606
7.603
7.539
7.519
7.505
7.501
7.348
7.344
7.328
7.325
7.270
7.266
7.248
7.230
7.227
7.062
7.059
7.042
7.039
6.798
6.795
6.779
6.776
6.760
6.756
6.110
6.091
6.055
6.036
2.952
2.934
2.917
2.900
2.883
2.866
2.849
1.120
1.103
1.099
1.082
0.023
Cl
H
N
O
S
5ma
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.07
1.07
2.11
1.04
1.07
1.07
1.09
1.00
1.11
1.02
6.08

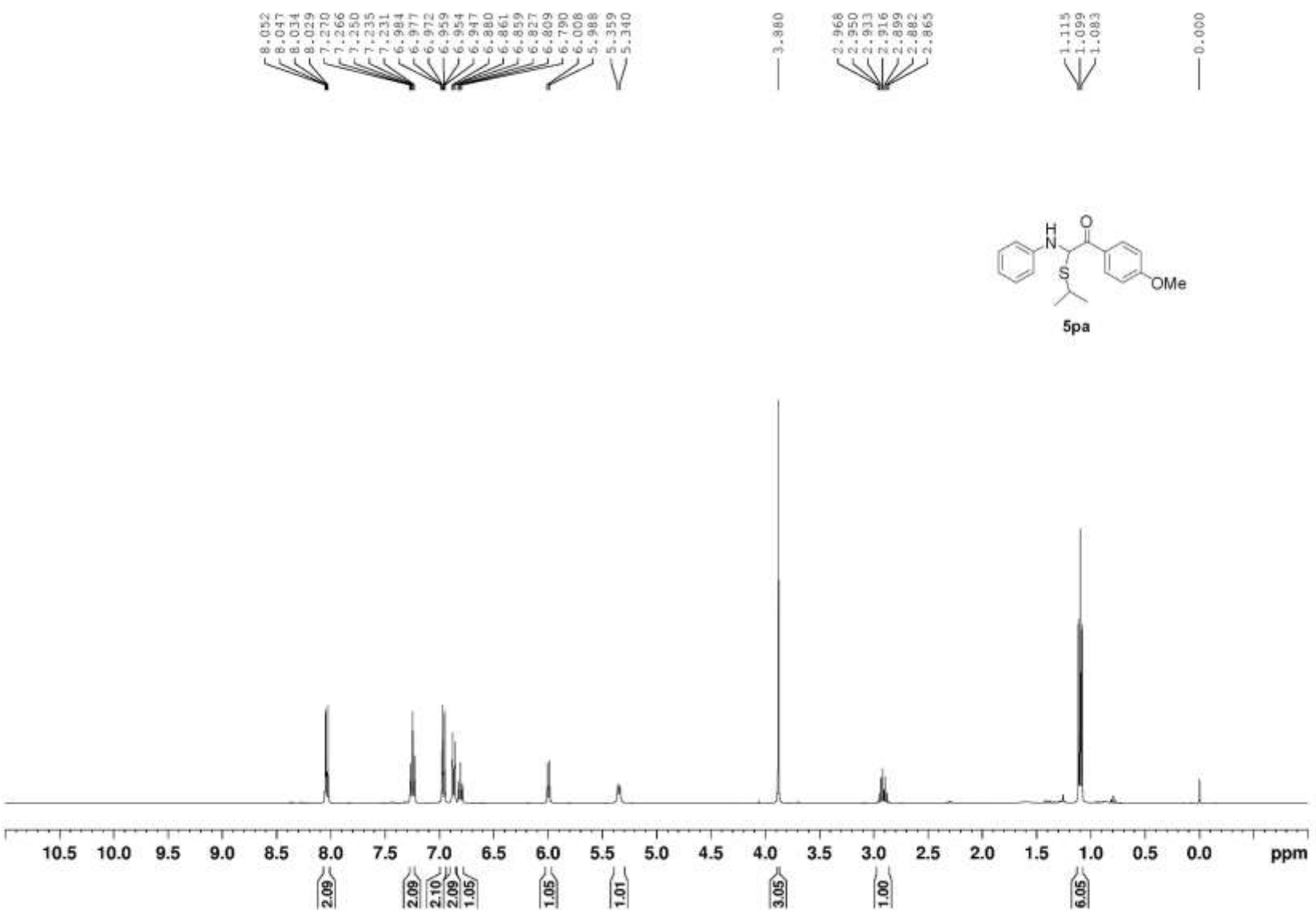

190.53
139.85
133.99
133.65
129.30
128.73
128.67
127.58
120.31
118.81
113.69
77.32
77.00
76.68
59.22
33.17
24.94
24.36
Cl
H
N
O
S
5ma
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

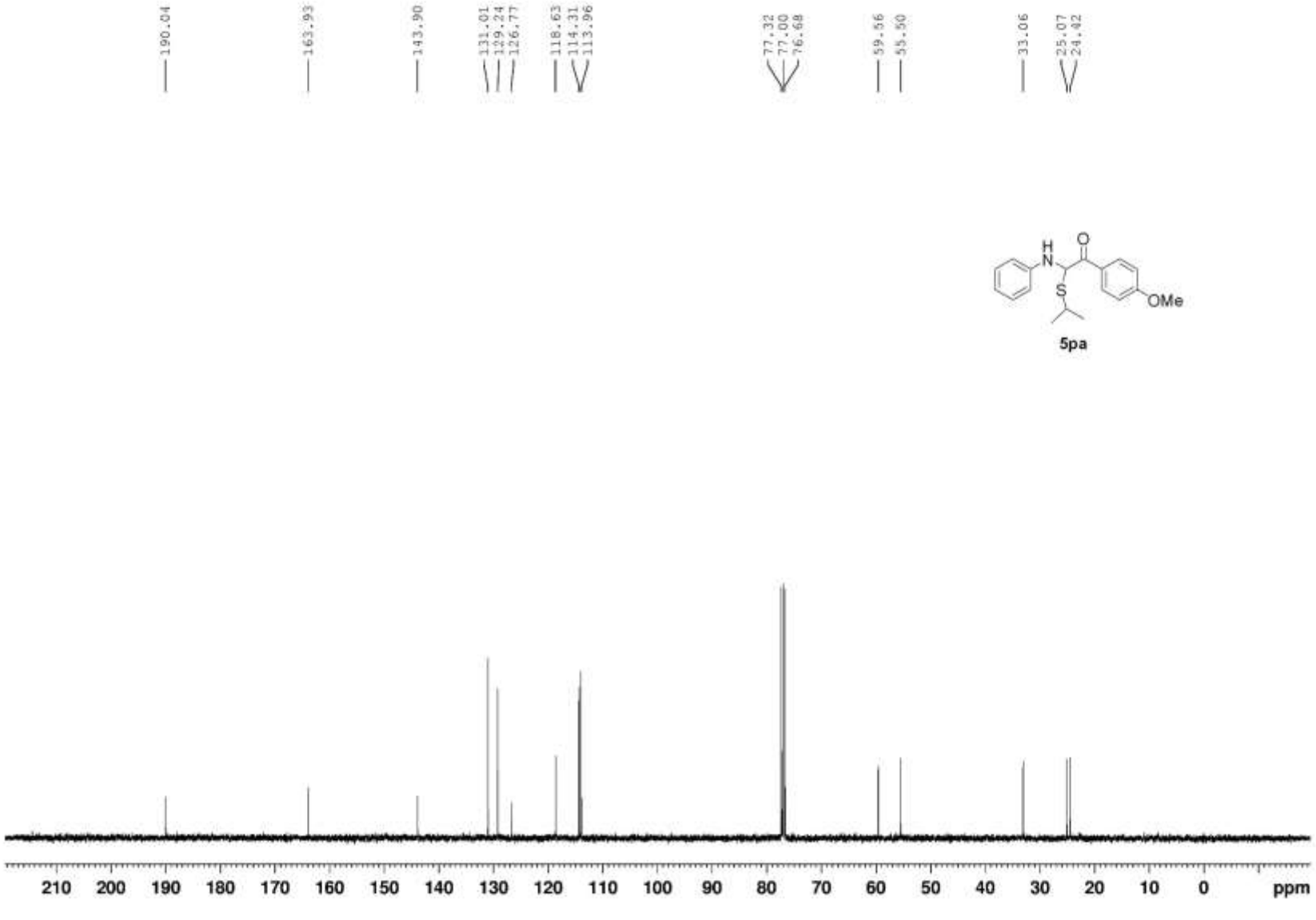

8.074
8.056
8.052
7.641
7.639
7.623
7.607
7.604
7.534
7.514
7.499
7.495
7.270
7.194
7.174
7.154
6.917
6.911
6.906
6.818
6.815
6.813
6.798
6.795
6.794
6.778
6.774
6.758
6.753
6.003
5.983
5.499
5.480
2.944
2.927
2.910
2.893
2.875
2.858
2.841
1.132
1.115
1.100
0.026
Cl
H
N
O
S
5na
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.10
1.05
2.08
1.06
1.04
2.09
1.06
1.03
1.00
6.04

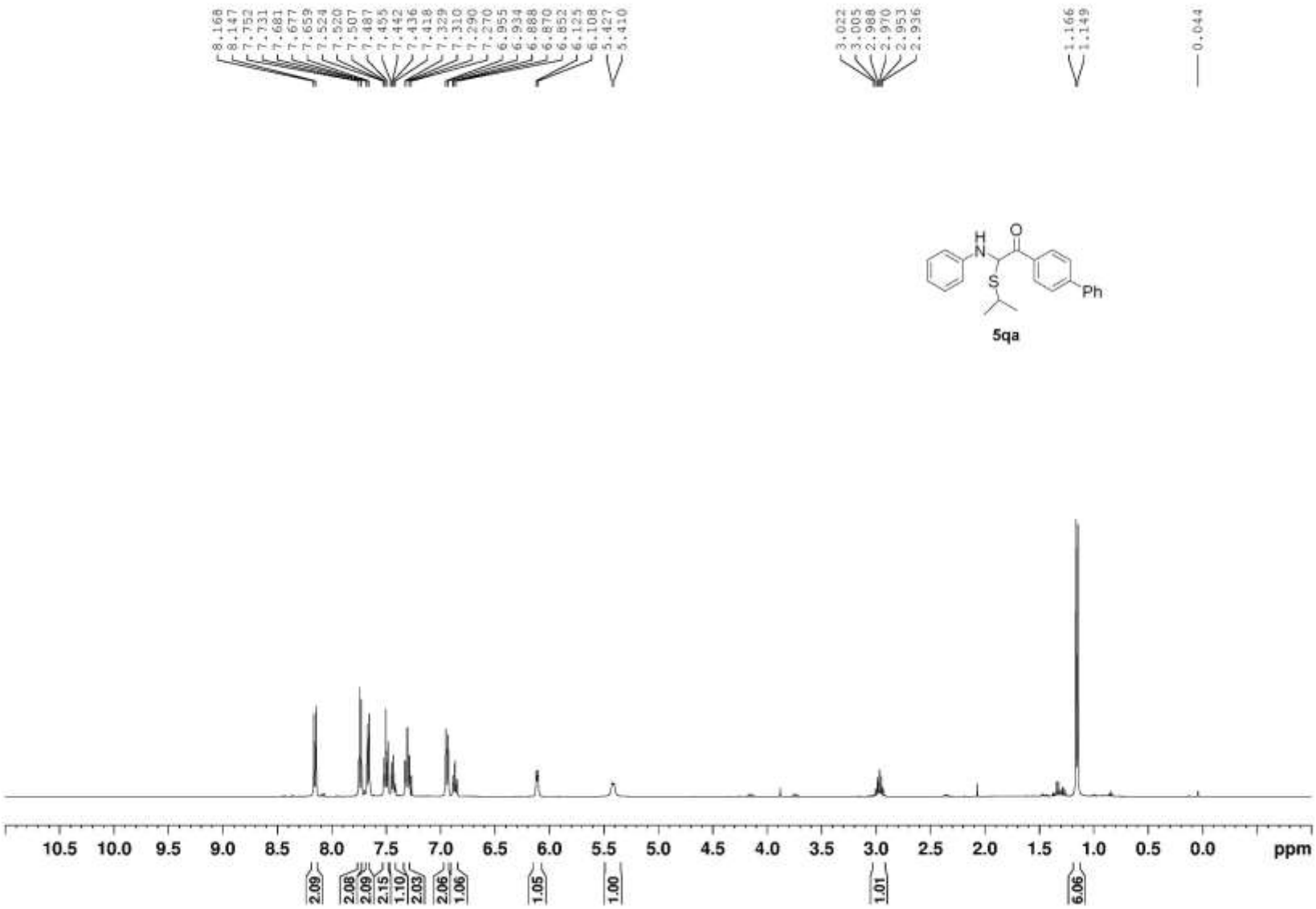

190.77
144.88
134.96
133.89
133.70
130.19
128.73
128.66
118.63
114.05
112.61
77.32
77.00
76.68
59.36
33.15
25.05
24.30
Cl
H
N
O
S
5na
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

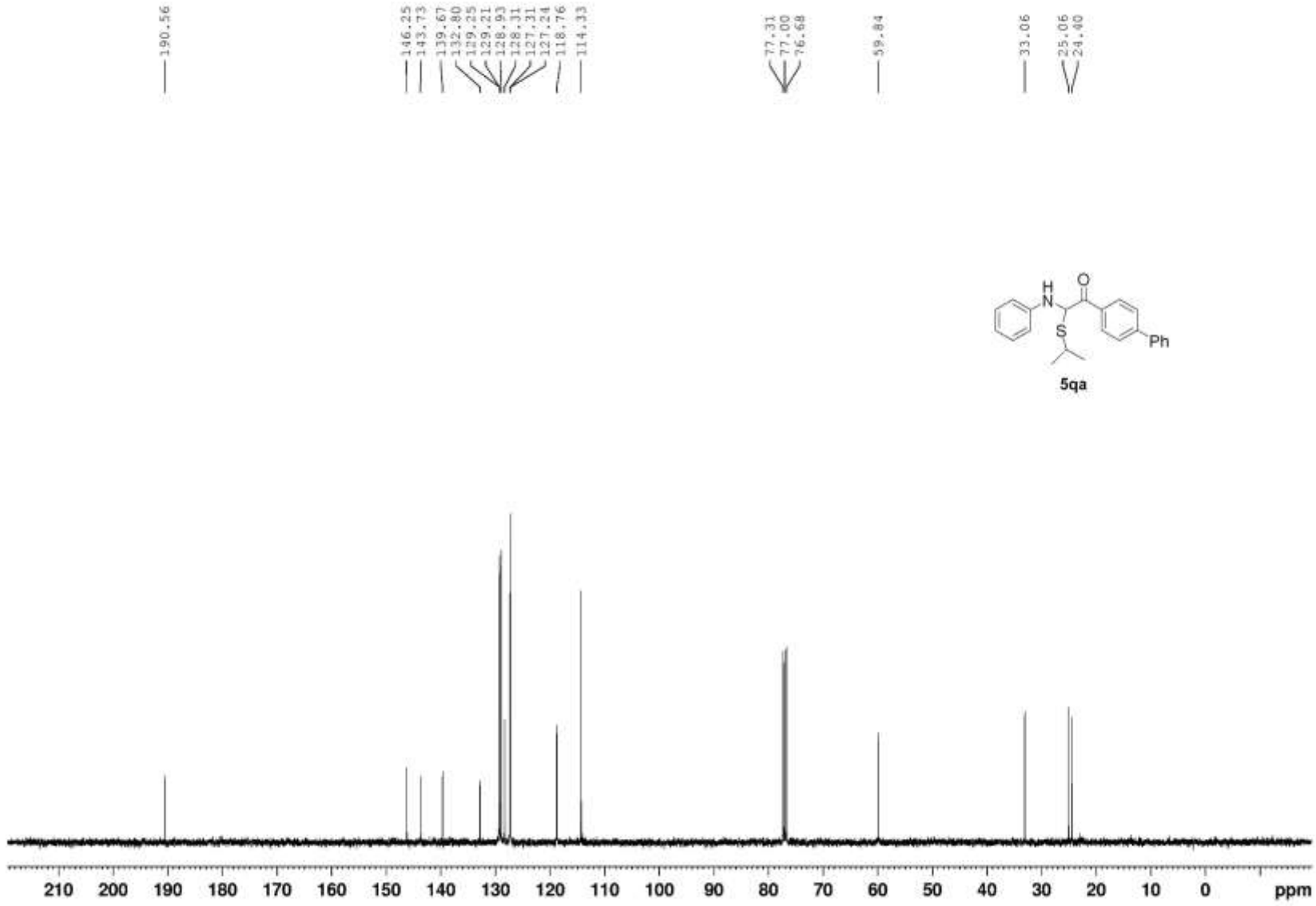

7.985
7.965
7.325
7.304
7.285
7.283
7.270
7.264
6.919
6.900
6.863
6.844
6.826
6.060
6.041
5.394
5.375
2.979
2.962
2.945
2.928
2.910
2.893
2.876
2.451
1.134
1.127
1.117
1.110
0.033
5oa
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.13
4.33
2.14
1.09
1.07
1.00
1.02
3.10
6.08

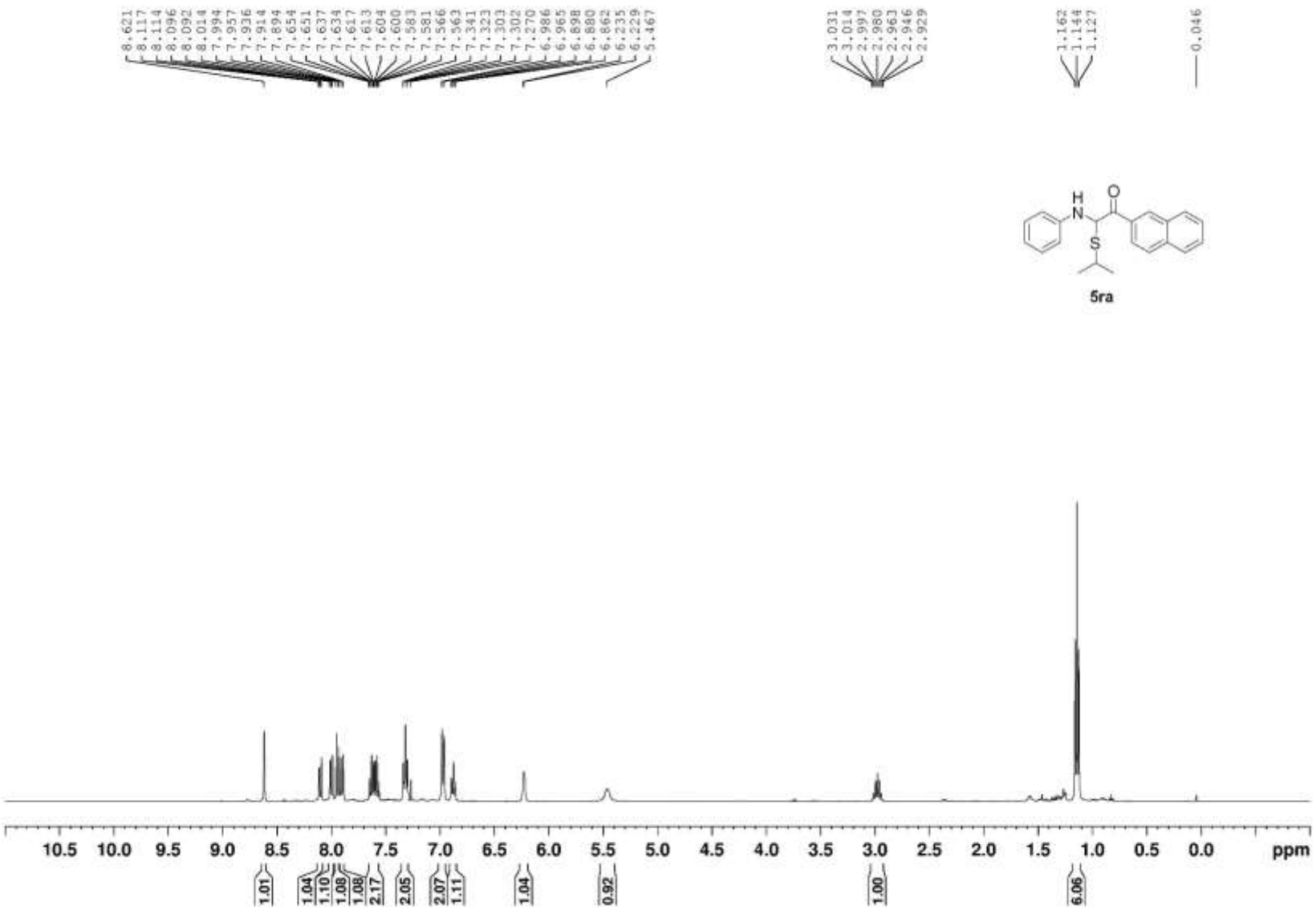

190.81
144.53
143.79
131.54
129.42
129.22
128.73
118.67
114.29
77.32
77.00
76.68
59.68
32.99
25.05
24.38
21.69
H
N
O
S
5oa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm


8.052
8.047
8.034
8.029
7.270
7.266
7.250
7.235
7.231
6.984
6.977
6.972
6.959
6.954
6.947
6.880
6.861
6.859
6.827
6.809
6.790
6.008
5.988
5.359
5.340
3.880
2.968
2.950
2.933
2.916
2.899
2.882
2.865
1.115
1.099
1.083
0.000
H
N
O
S
OMe
5pa
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.09
2.09
2.10
2.09
1.05
1.05
1.01
3.05
1.00
6.05

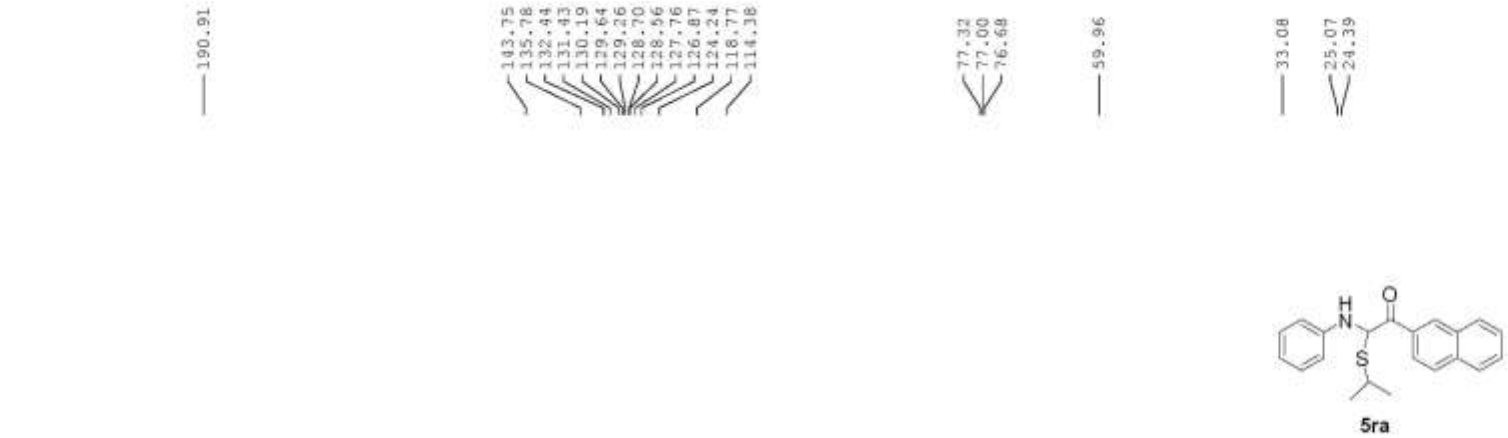

190.04
163.93
143.90
131.01
129.24
126.77
118.63
114.31
113.96
77.32
77.00
76.68
59.56
55.50
33.06
25.07
24.42
H
N
O
S
OMe
5pa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

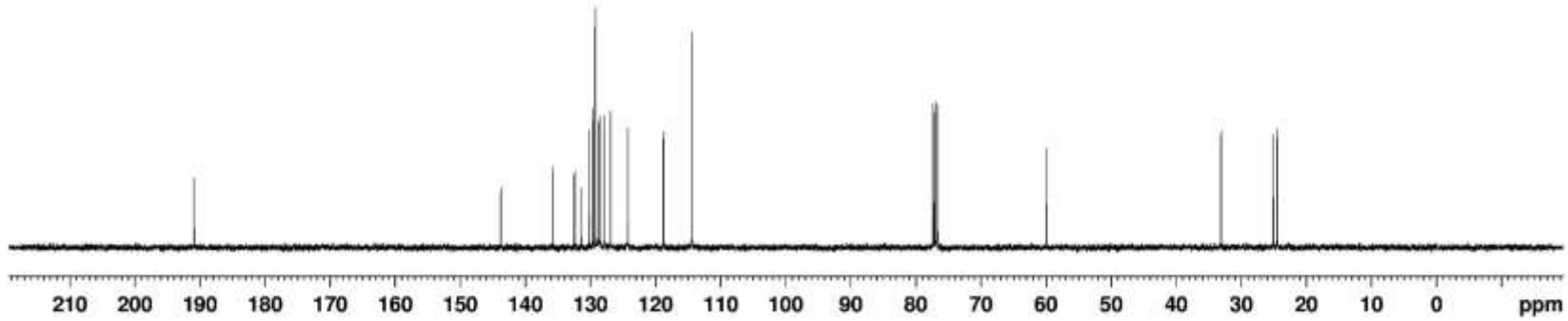

8.168
8.147
7.752
7.731
7.681
7.677
7.659
7.524
7.520
7.507
7.487
7.455
7.442
7.436
7.418
7.329
7.310
7.290
7.270
6.955
6.934
6.888
6.870
6.852
6.125
6.108
5.427
5.410
3.022
3.005
2.988
2.970
2.953
2.936
1.166
1.149
0.044
H
N
O
S
Ph
5qa
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.09
2.08
2.09
2.15
1.10
2.03
2.06
1.06
1.05
1.00
1.01
6.06

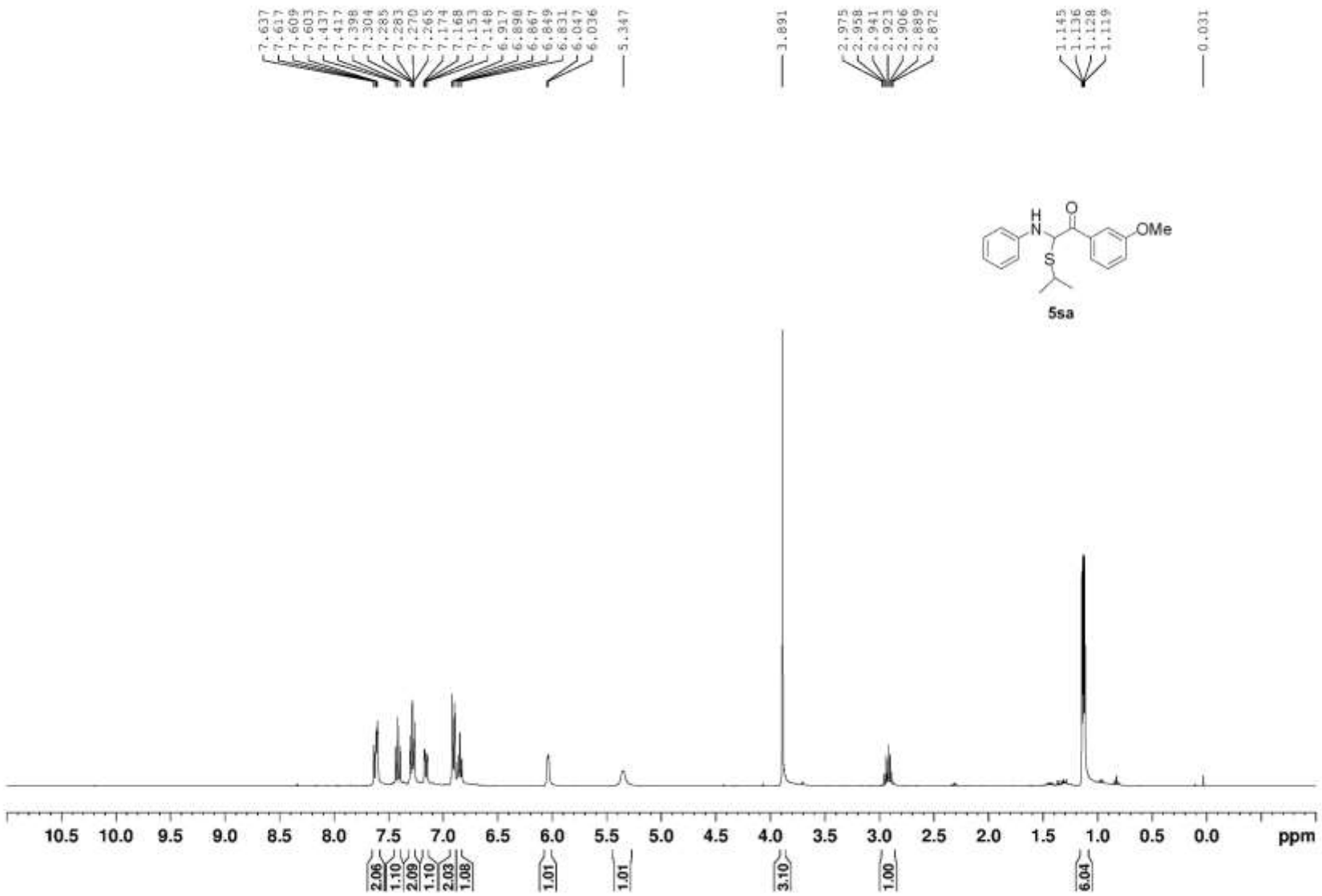

190.56
146.25
143.73
139.67
132.80
129.25
129.21
128.93
128.31
127.31
127.24
118.76
114.33
77.31
77.00
76.68
59.84
33.06
25.06
24.40
H
N
O
S
Ph
5qa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

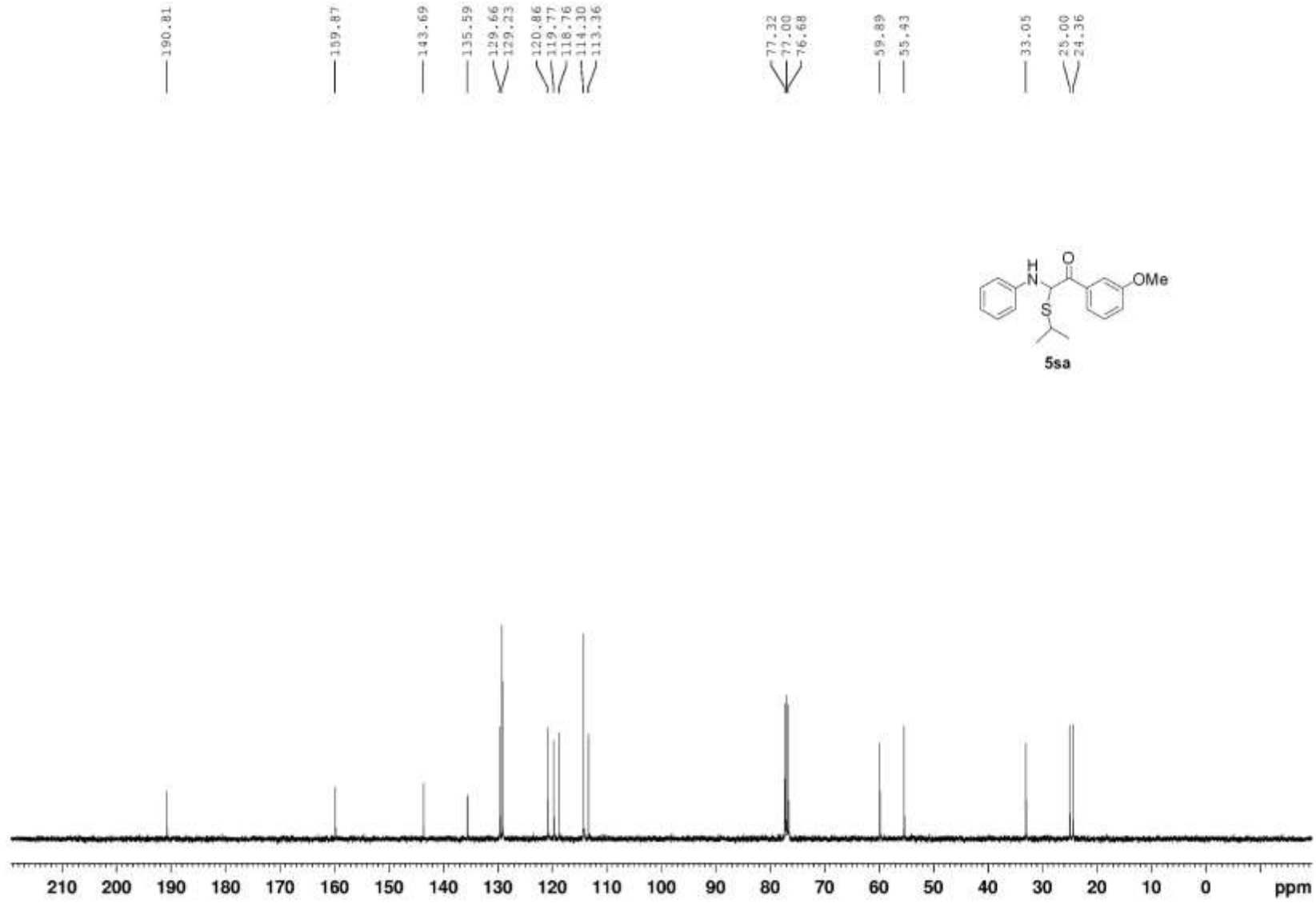

8.621
8.117
8.114
8.096
8.092
8.014
7.994
7.957
7.936
7.914
7.894
7.654
7.651
7.637
7.634
7.617
7.613
7.604
7.600
7.583
7.581
7.566
7.563
7.341
7.323
7.303
7.302
7.270
6.986
6.965
6.898
6.880
6.862
6.235
6.229
5.467
3.031
3.014
2.997
2.980
2.963
2.946
2.929
1.162
1.144
1.127
0.046
O
N
H
S
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.01
1.04
1.10
1.08
1.08
2.17
2.05
2.07
1.11
1.04
0.92
1.00
6.06

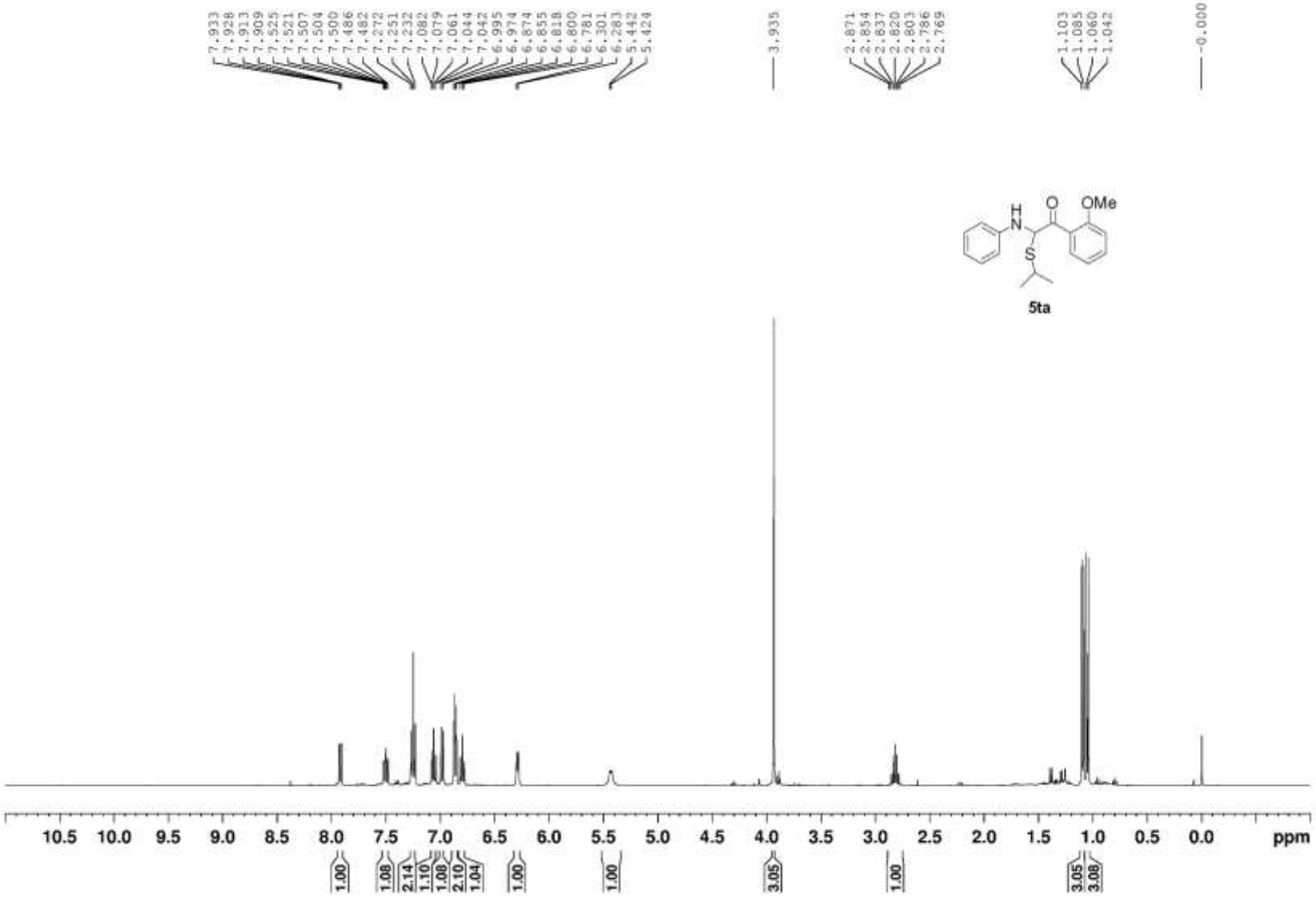
5ra

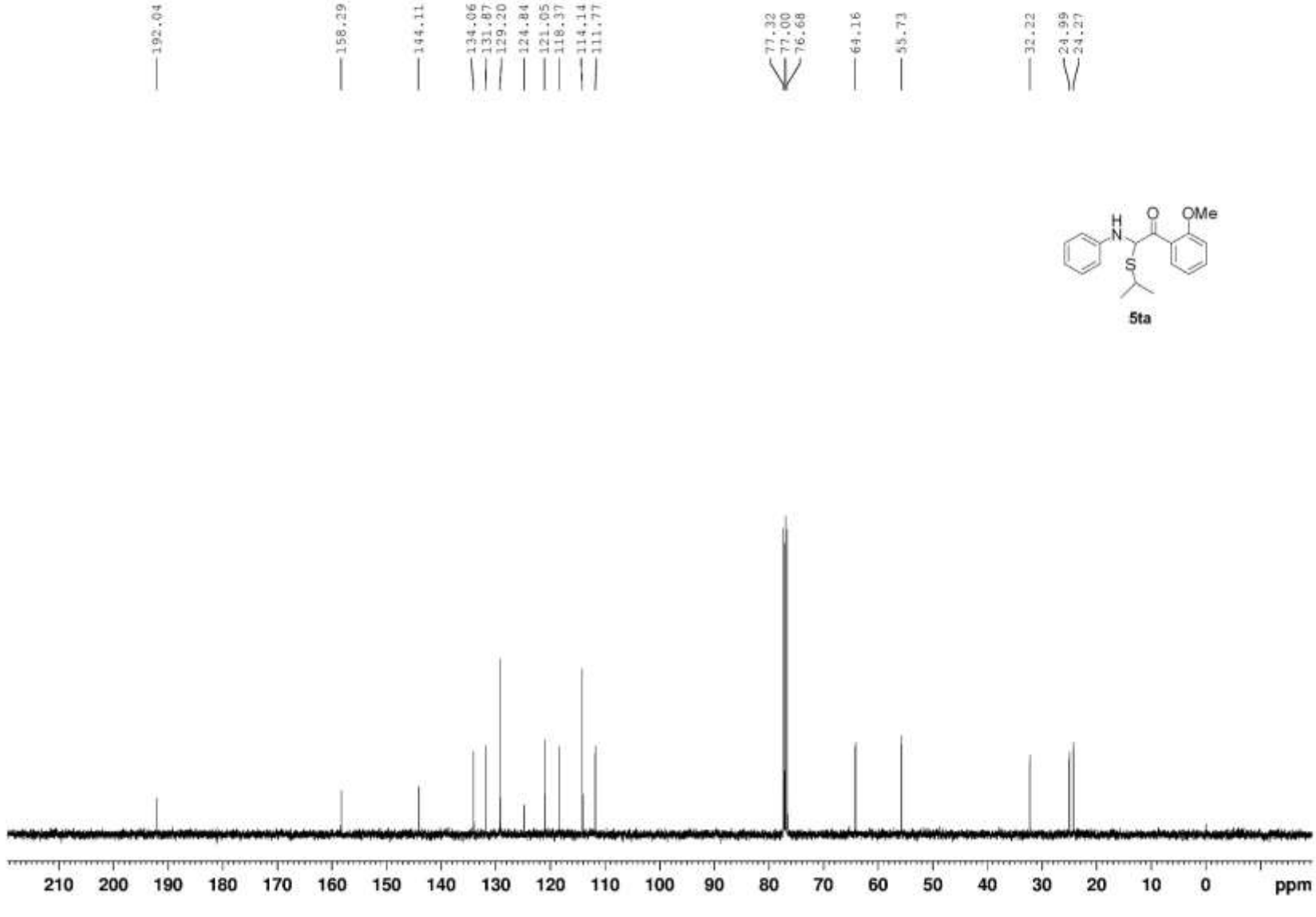

190.91
143.75
135.78
132.44
131.43
130.19
129.64
129.26
128.70
128.56
127.76
126.87
124.24
118.77
114.38
77.32
77.00
76.68
59.96
33.08
25.07
24.39
H
N
O
S
5ra

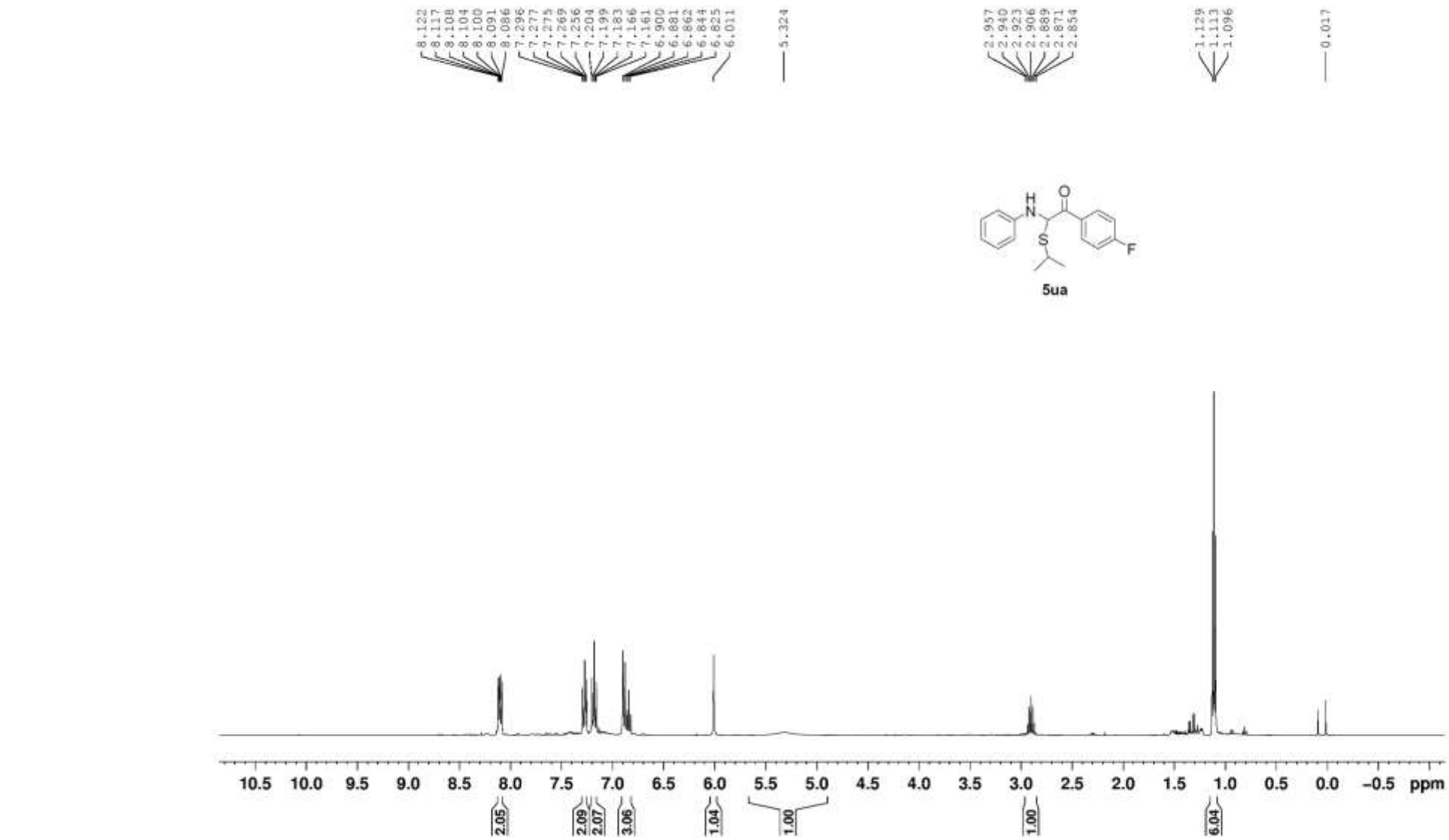

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

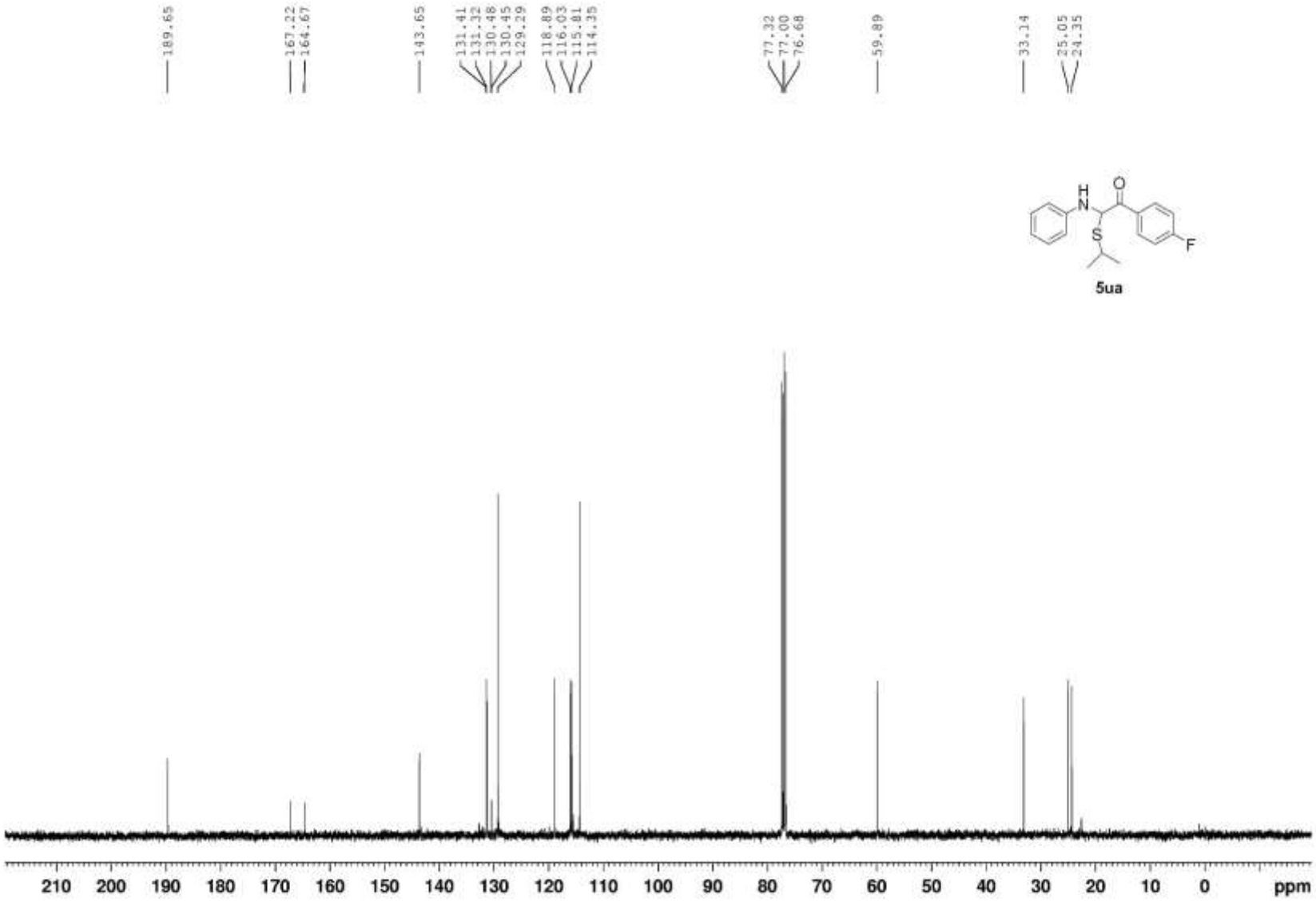

7.637
7.617
7.609
7.603
7.437
7.417
7.398
7.304
7.285
7.283
7.270
7.265
7.174
7.168
7.153
7.148
6.917
6.898
6.867
6.849
6.831
6.047
6.036
5.347
3.891
2.975
2.958
2.941
2.923
2.906
2.889
2.872
1.145
1.136
1.128
1.119
0.031
OMe
5sa
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.06
1.10
2.09
1.10
2.03
1.08
1.01
1.01
3.10
1.00
6.04

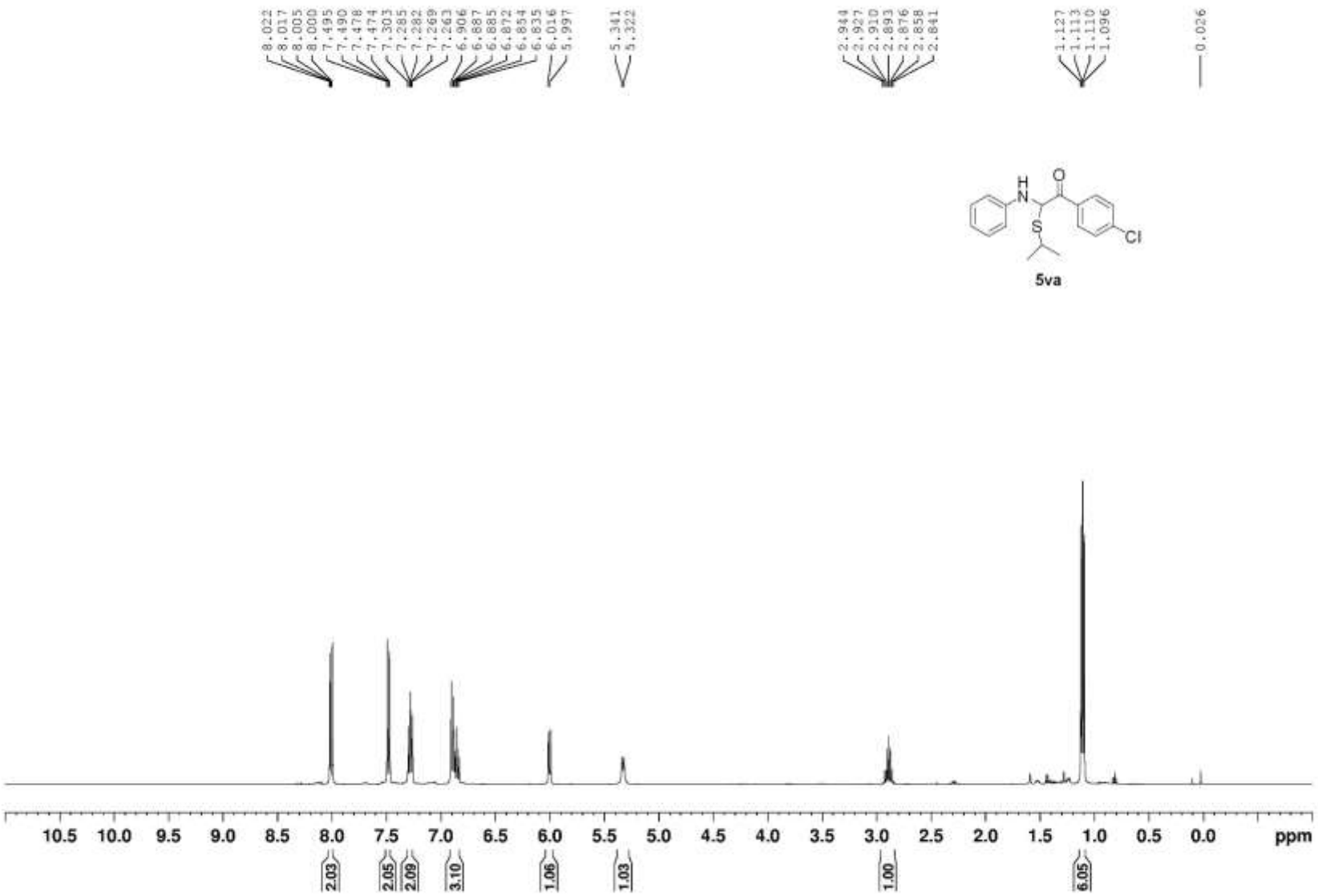

190.81
159.87
143.69
135.59
129.66
129.23
120.86
119.77
118.76
114.30
113.36
77.32
77.00
76.68
59.89
55.43
33.05
25.00
24.36
H
N
O
S
OMe
5sa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

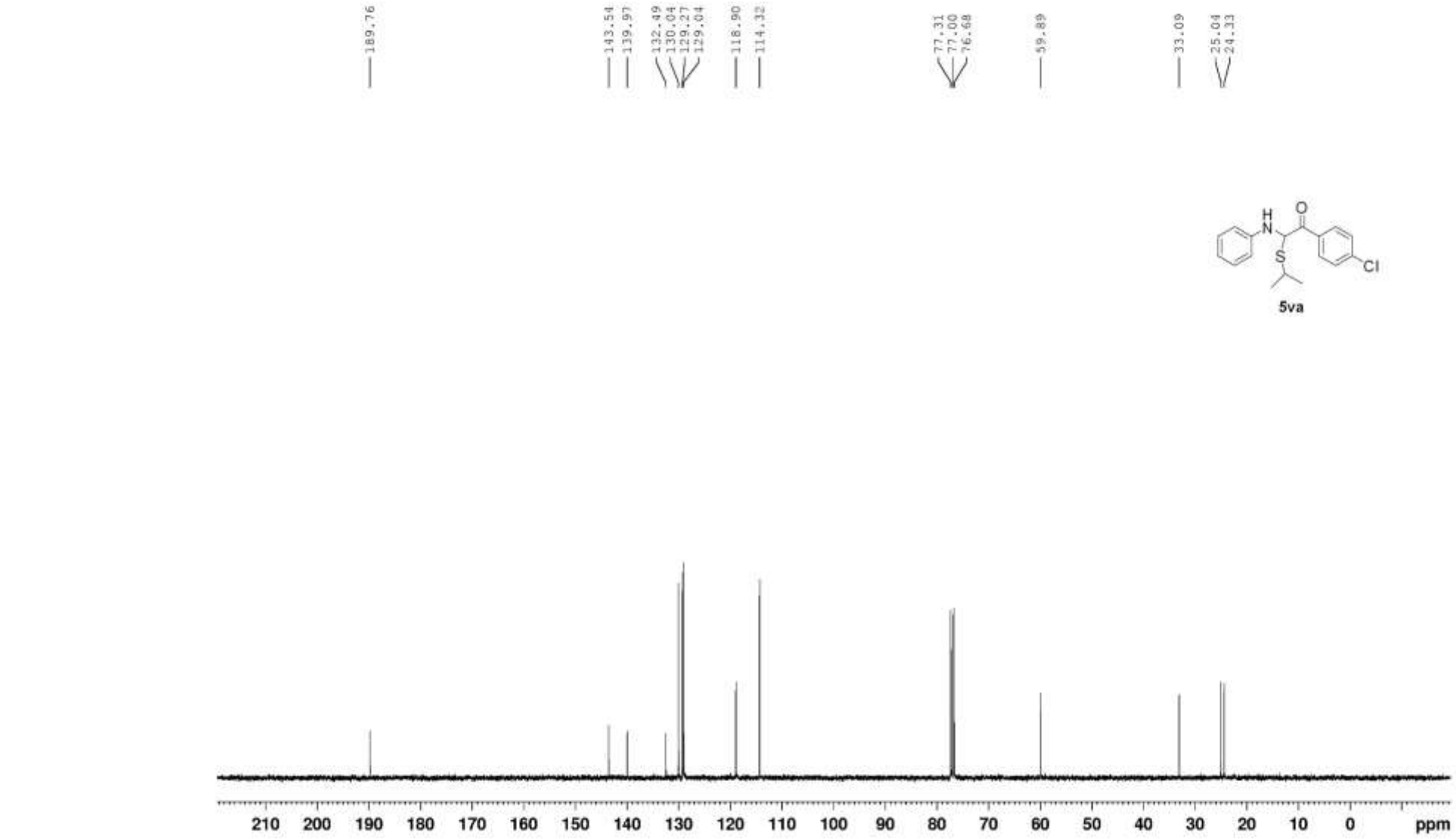

7.933
7.928
7.913
7.909
7.525
7.521
7.507
7.504
7.500
7.486
7.482
7.272
7.251
7.232
7.082
7.079
7.061
7.044
7.042
6.995
6.974
6.874
6.855
6.818
6.800
6.781
6.301
6.283
5.442
5.424
3.935
2.871
2.854
2.837
2.820
2.803
2.786
2.769
1.103
1.085
1.060
1.042
-0.000
OMe
5ta
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
1.00 1.08 2.14 1.10 1.08 2.10 1.04 1.00 1.00 3.05 1.00 3.05 3.08

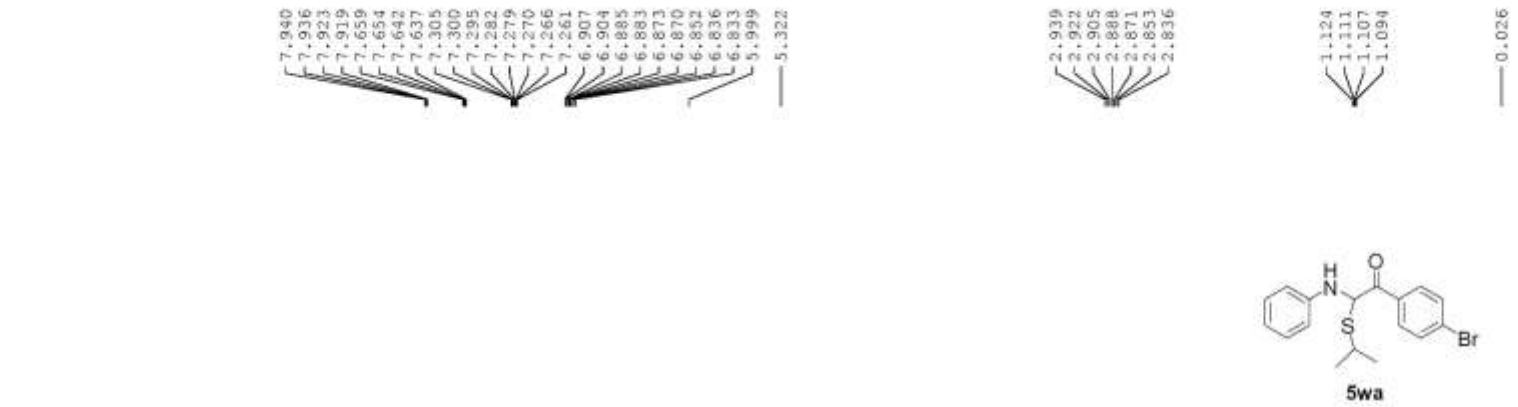

192.04
158.29
144.11
134.06
131.87
129.20
124.84
121.05
118.37
114.14
111.77
77.32
77.00
76.68
64.16
55.73
32.22
24.99
24.27
OMe
5ta
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

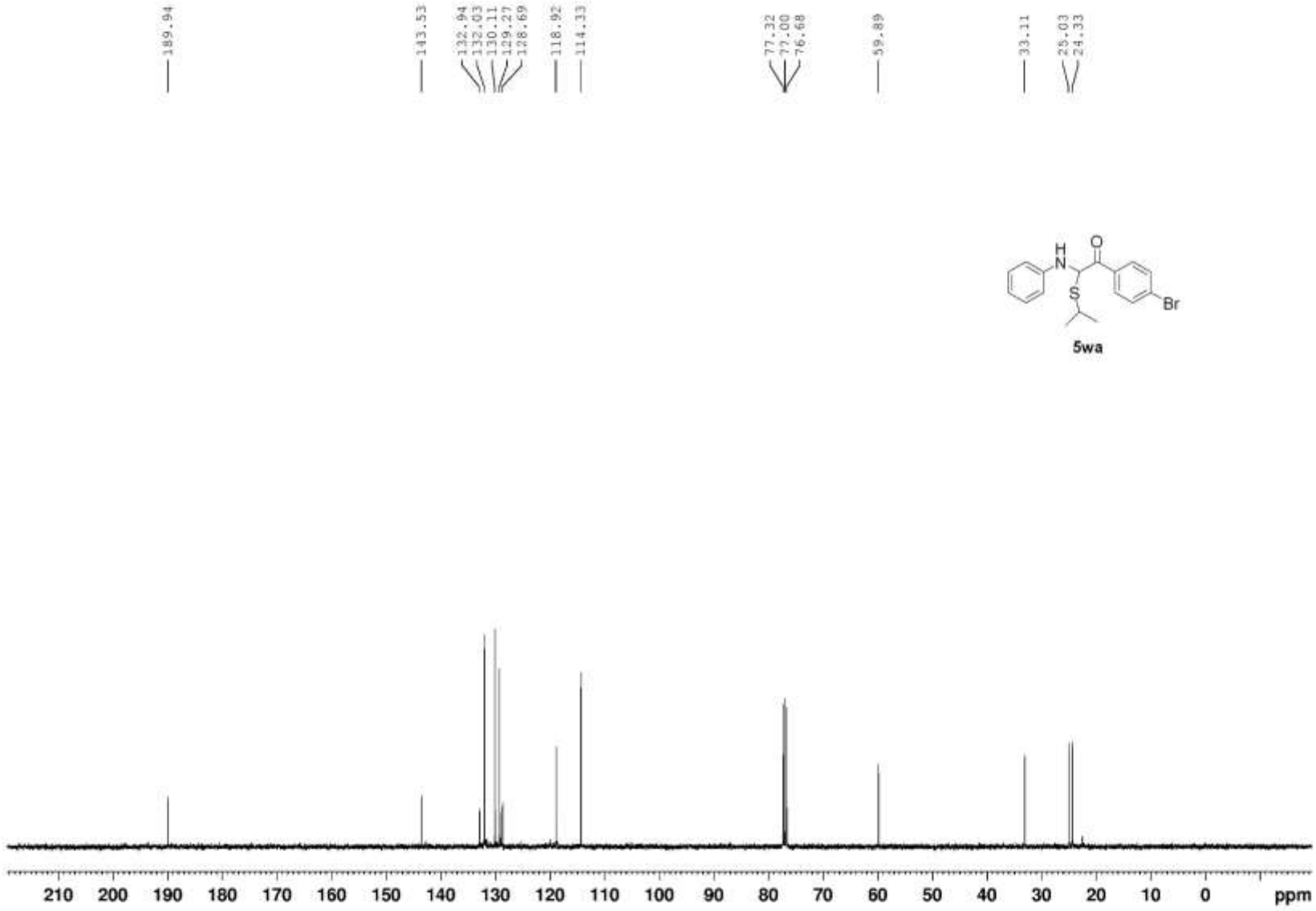

8.122
8.117
8.108
8.104
8.100
8.091
8.086
7.296
7.277
7.275
7.269
7.256
7.204
7.199
7.183
7.166
7.161
6.900
6.881
6.862
6.844
6.825
6.011
5.324
2.957
2.940
2.923
2.906
2.889
2.871
2.854
1.129
1.113
1.096
0.017
H
N
O
S
F
5ua
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 −0.5 ppm
2.05
2.09
2.07
3.06
1.04
1.00
1.00
6.04

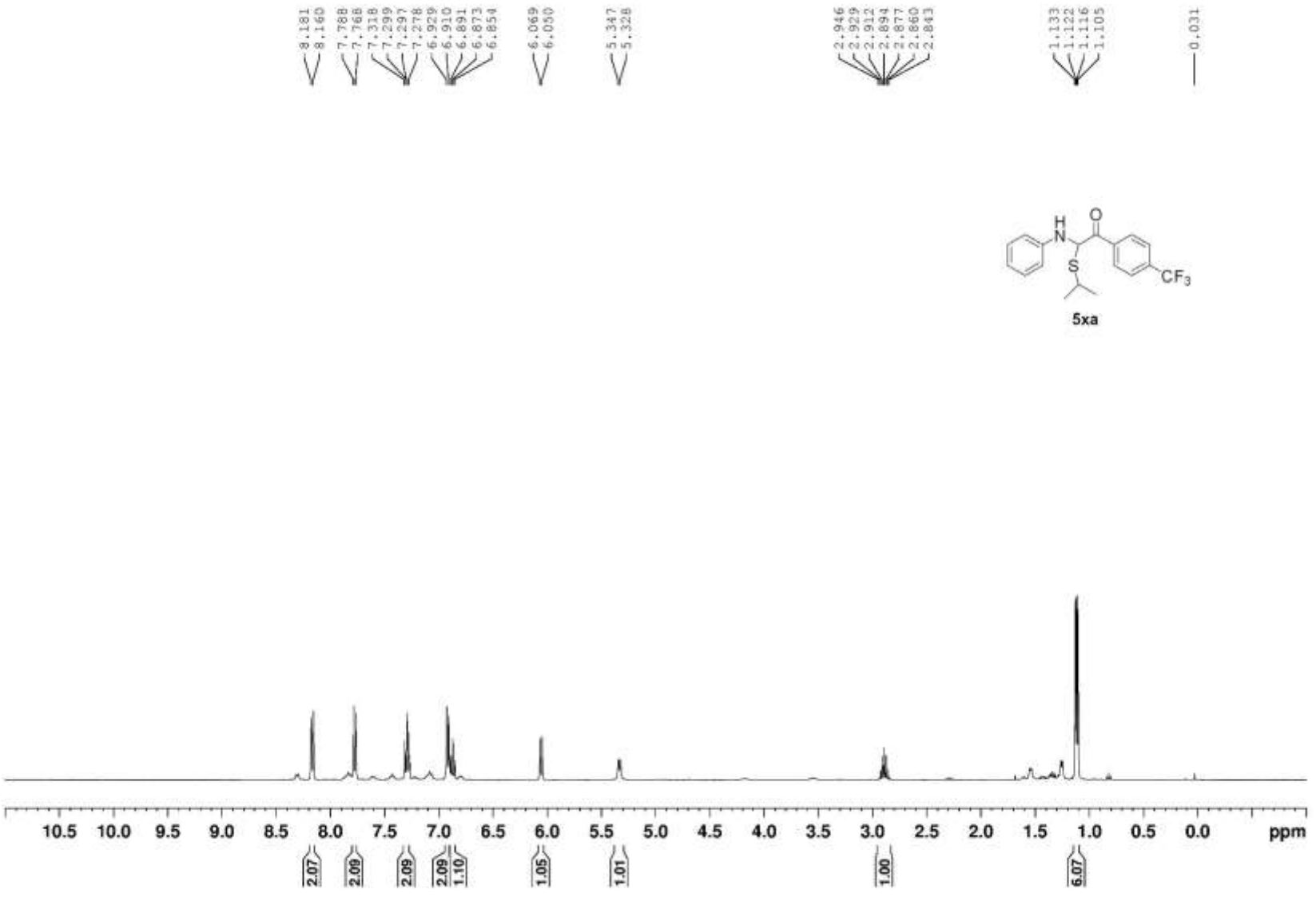

189.65
167.22
164.67
143.65
131.41
131.32
130.48
130.45
129.29
118.89
116.03
115.81
114.35
77.32
77.00
76.68
59.89
33.14
25.05
24.35
H
N
O
S
F
5ua
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

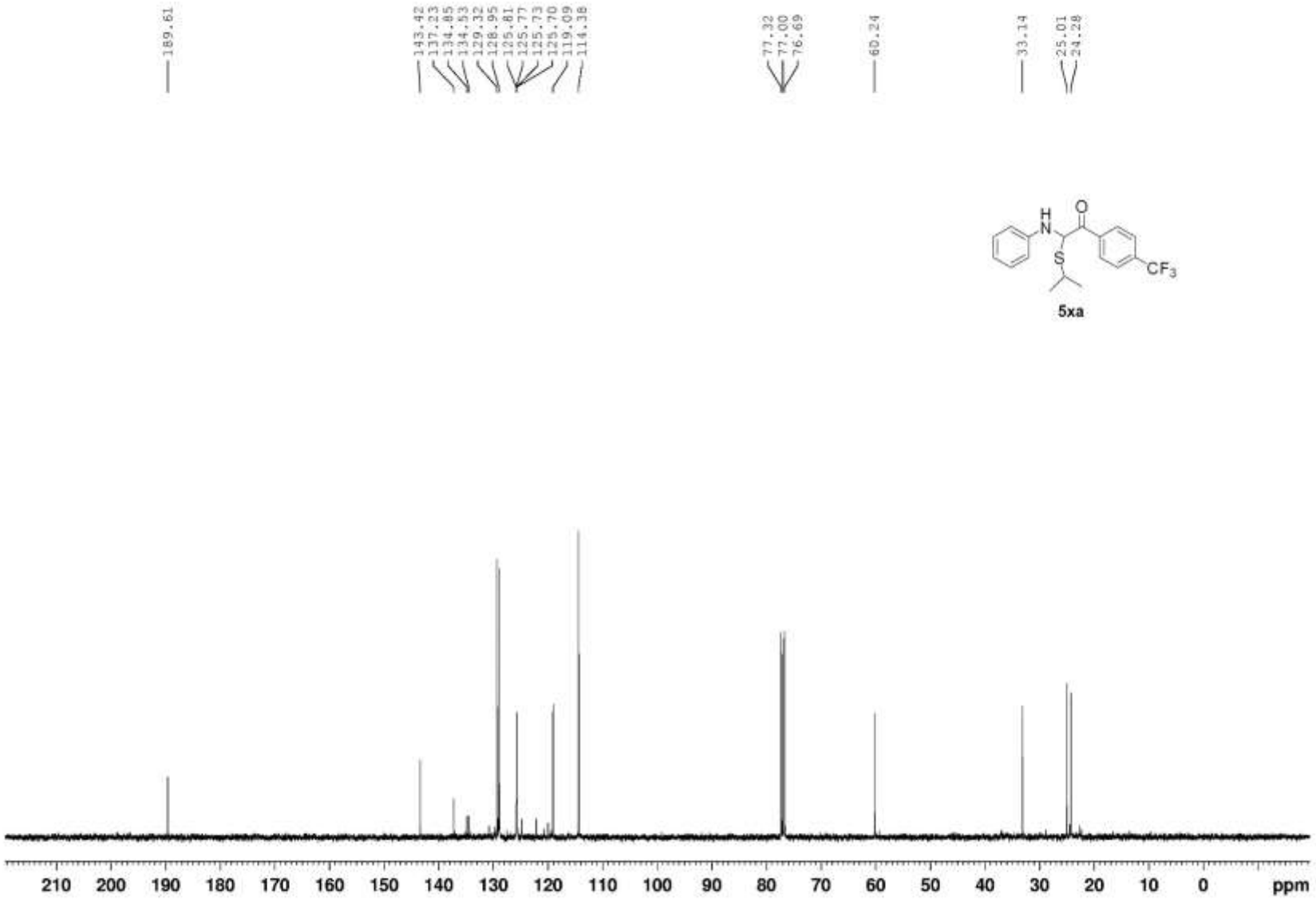

8.022
8.017
8.005
8.000
7.495
7.490
7.478
7.474
7.303
7.285
7.282
7.269
7.263
6.906
6.887
6.885
6.872
6.854
6.835
6.016
5.997
5.341
5.322
2.944
2.927
2.910
2.893
2.876
2.858
2.841
1.127
1.113
1.110
1.096
0.026
H
N
O
S
Cl
5va
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.03
2.05
2.09
3.10
1.06
1.03
1.00
6.05

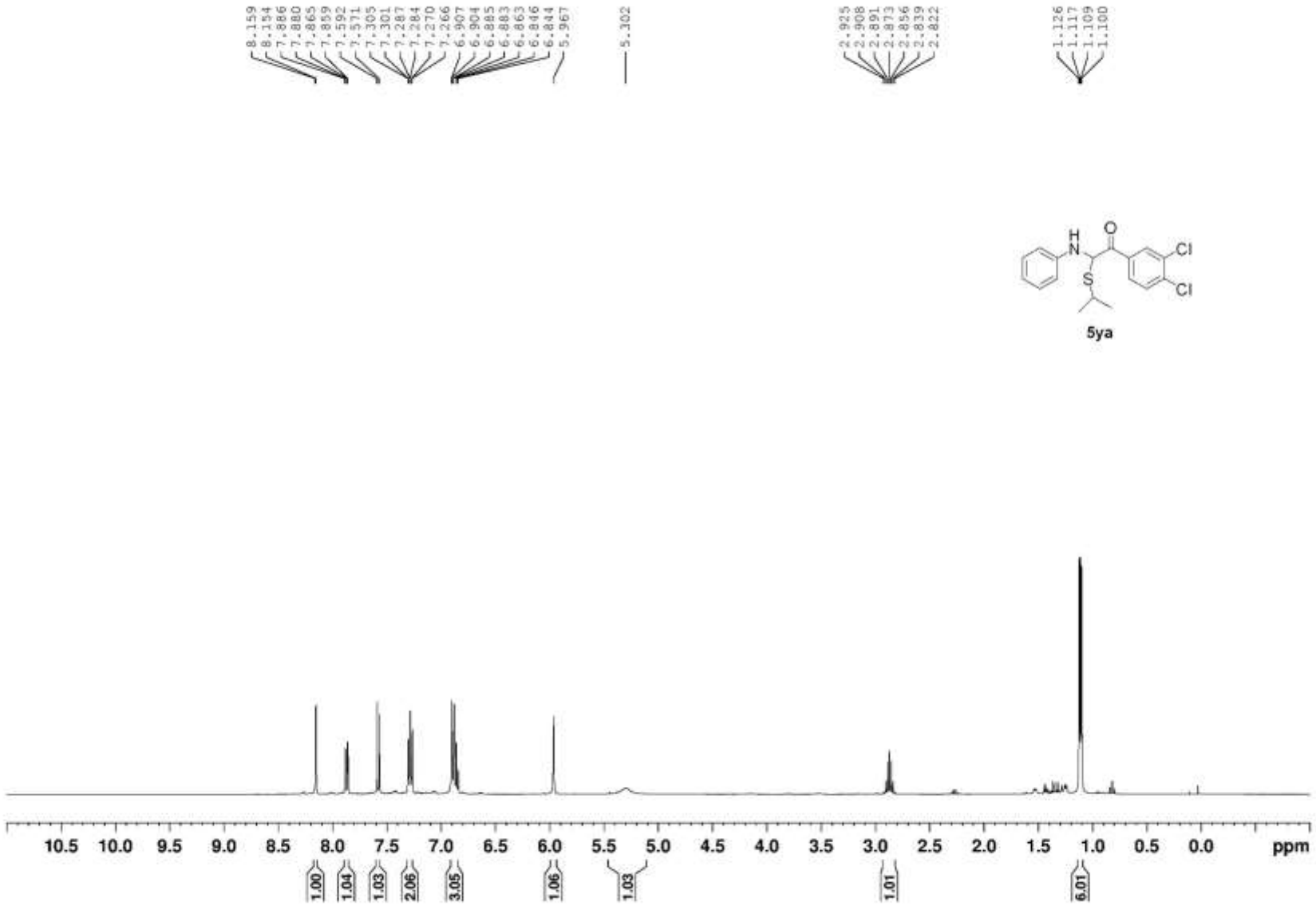

189.76
143.54
139.97
132.49
130.04
129.27
129.04
118.90
114.32
77.31
77.00
76.68
59.89
33.09
25.04
24.33
H
N
O
S
Cl
5va
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

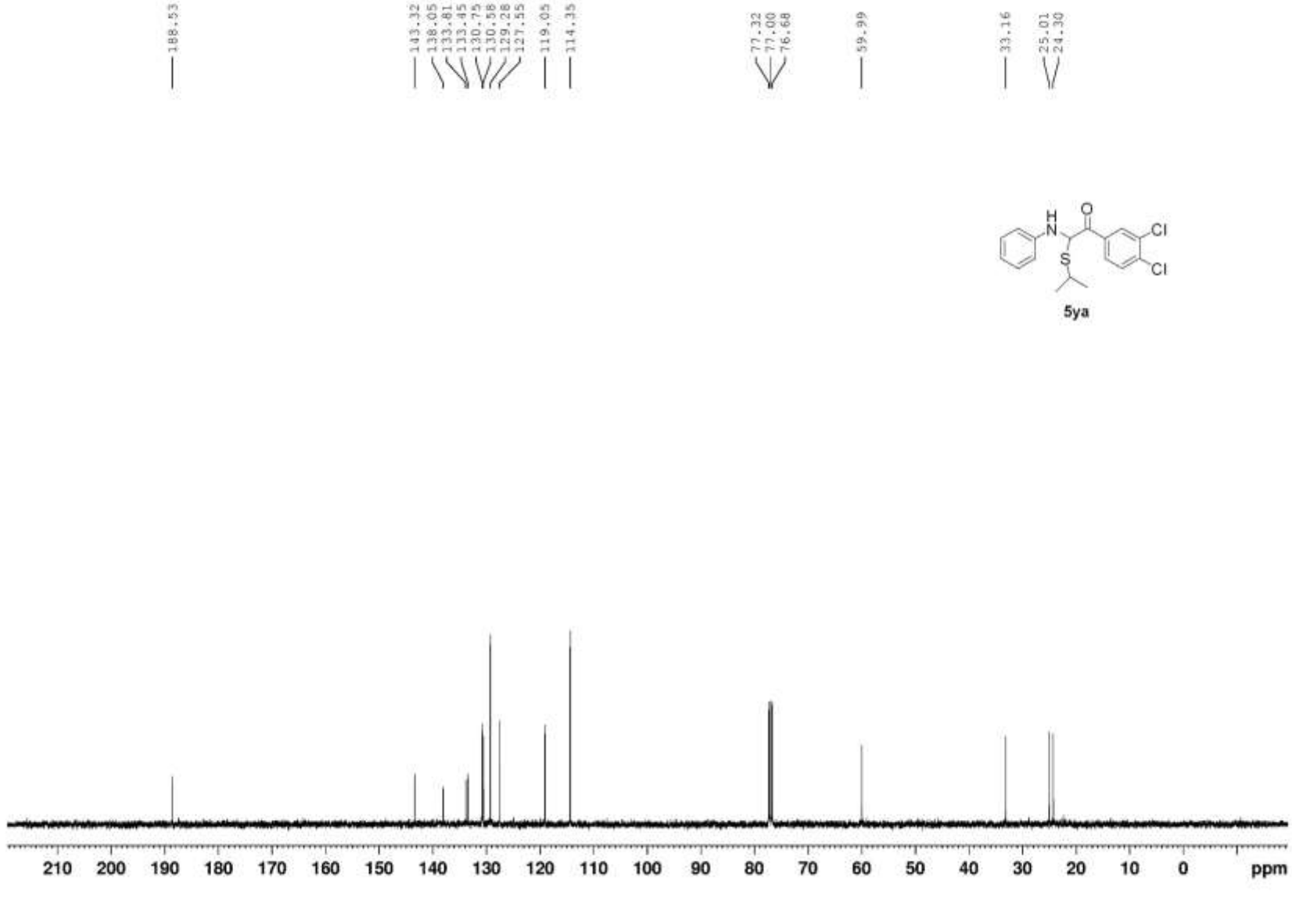

7.940
7.936
7.923
7.919
7.659
7.654
7.642
7.637
7.305
7.300
7.295
7.282
7.279
7.270
7.266
7.261
6.907
6.904
6.885
6.883
6.873
6.870
6.852
6.836
6.833
5.999
5.322
2.939
2.922
2.905
2.888
2.871
2.853
2.836
1.124
1.111
1.107
1.094
0.026
H
N
O
S
Br
5wa
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.03
2.06
2.15
3.10
1.07
1.00
1.06
6.18

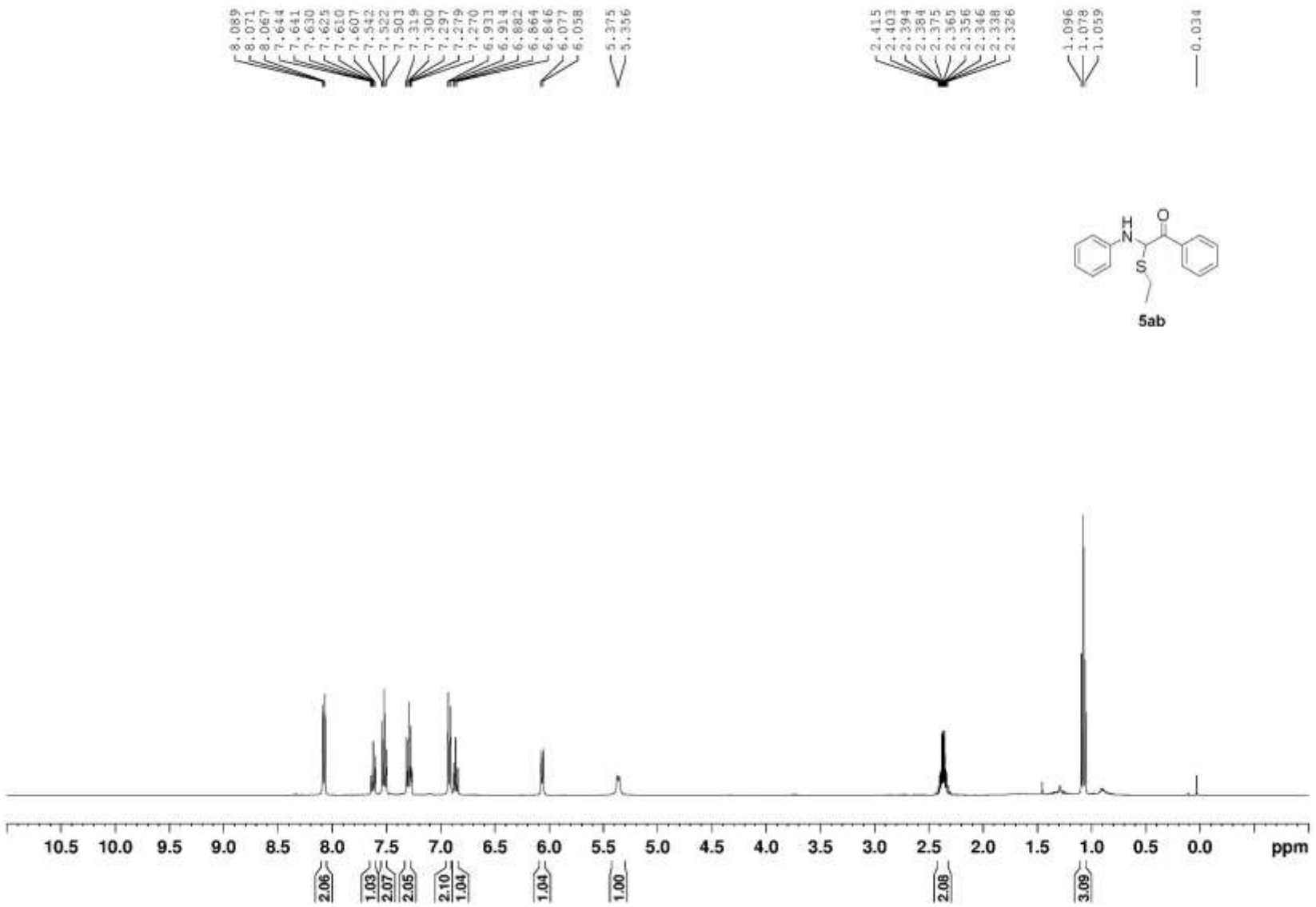

189.94
143.53
132.94
132.03
130.11
129.27
128.69
118.92
114.33
77.32
77.00
76.68
59.89
33.11
25.03
24.33
NH
O
S
Br
5wa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

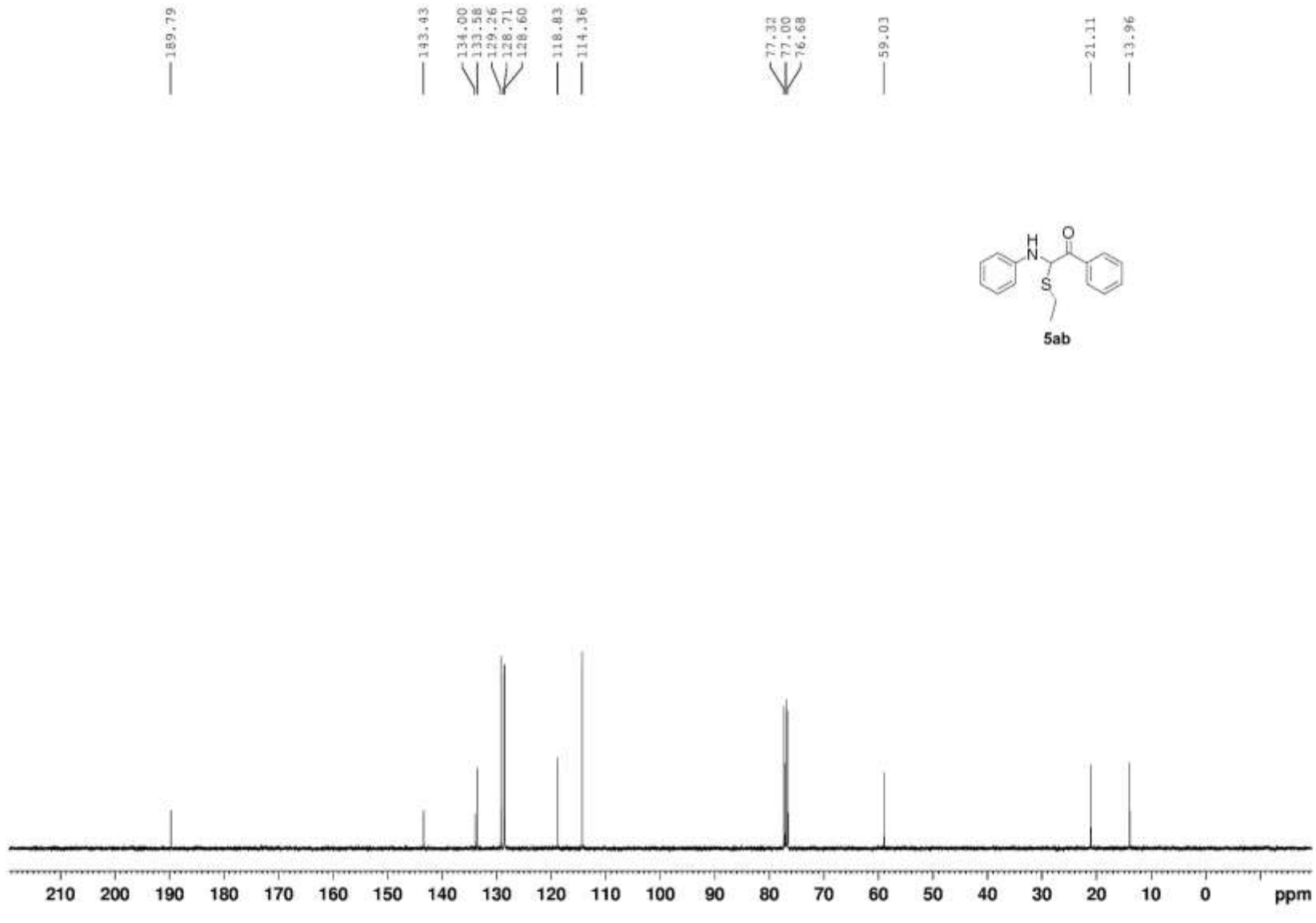

9.181
8.160
7.788
7.768
7.318
7.299
7.297
7.278
6.929
6.910
6.891
6.873
6.854
6.069
6.050
5.347
5.328
2.946
2.929
2.912
2.894
2.877
2.860
2.843
1.133
1.122
1.116
1.105
0.031
H
N
O
S
CF3
5xa
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.07
2.09
2.09
2.09
1.10
1.05
1.01
1.00
6.07

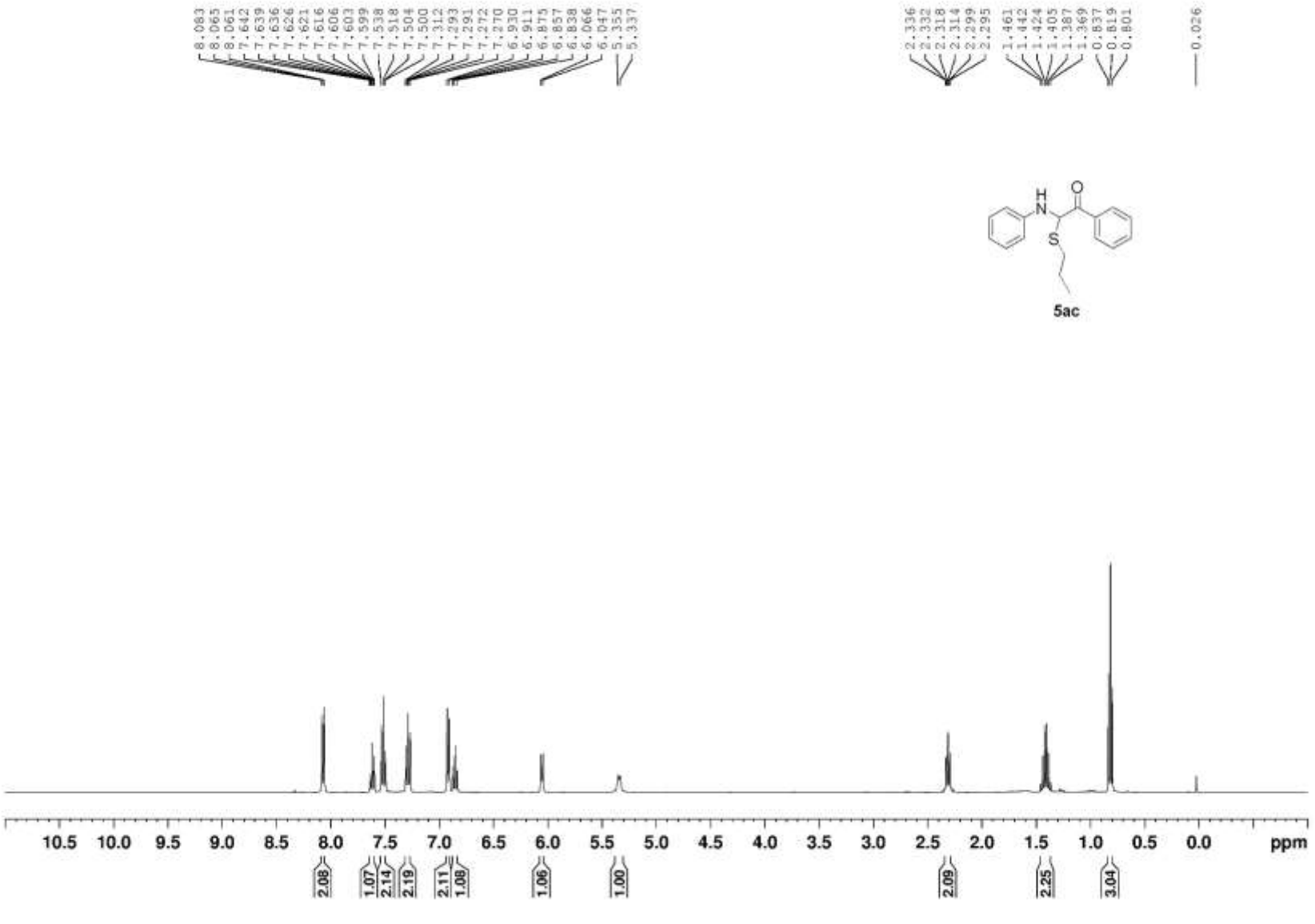

189.61
143.42
137.23
134.85
134.53
129.32
128.95
125.81
125.77
125.73
125.70
119.09
114.38
77.32
77.00
76.69
60.24
33.14
25.01
24.28
H
N
O
S
CF3
5xa
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

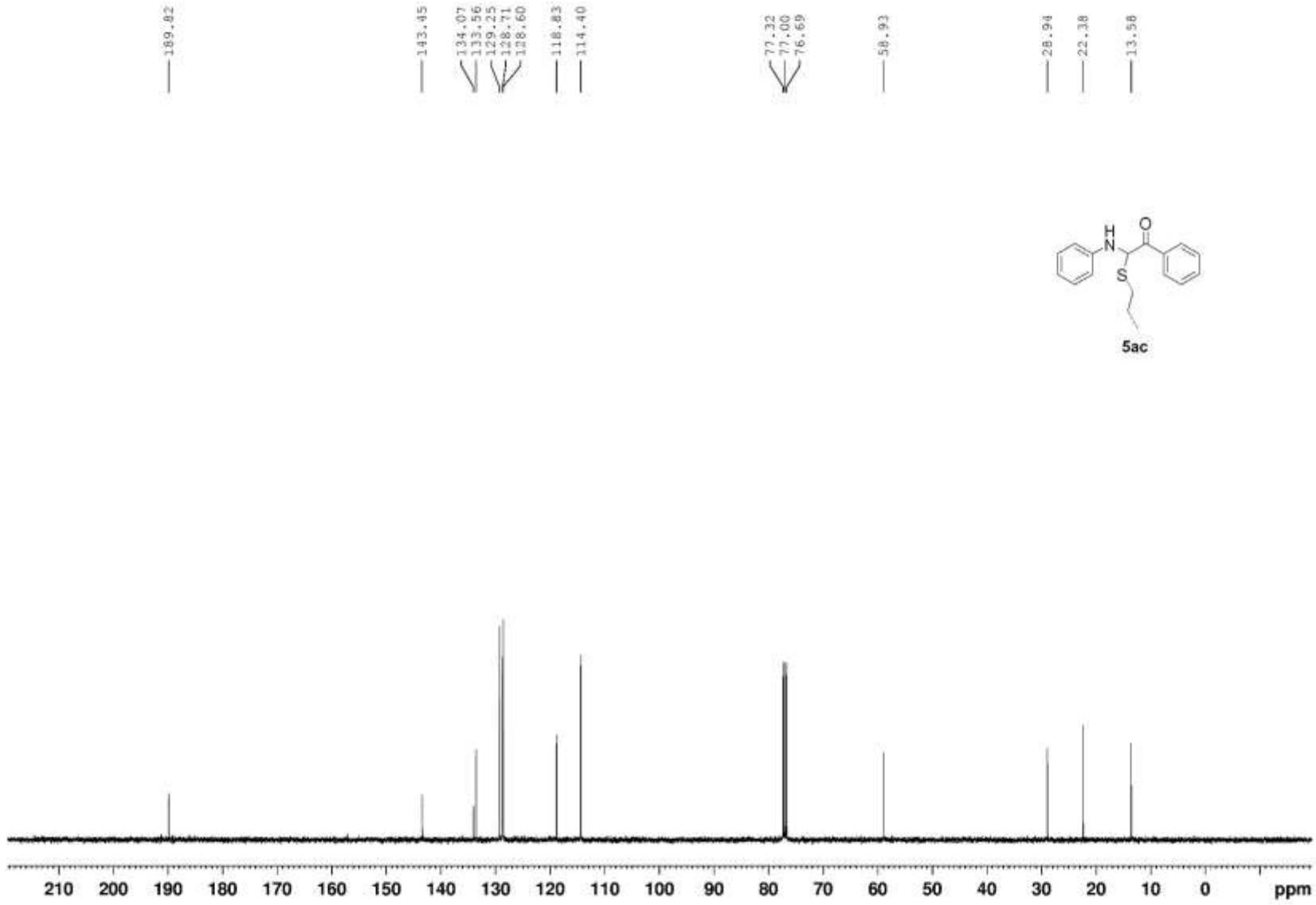

8.159
8.154
7.886
7.880
7.865
7.859
7.592
7.571
7.305
7.301
7.287
7.284
7.270
7.266
6.907
6.904
6.885
6.883
6.863
6.846
6.844
5.967
5.302
2.925
2.908
2.891
2.873
2.856
2.839
2.822
1.126
1.117
1.109
1.100
H
N
O
S
Cl
Cl
5ya
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.00
1.04
1.03
2.06
3.05
1.06
1.03
1.01
6.01

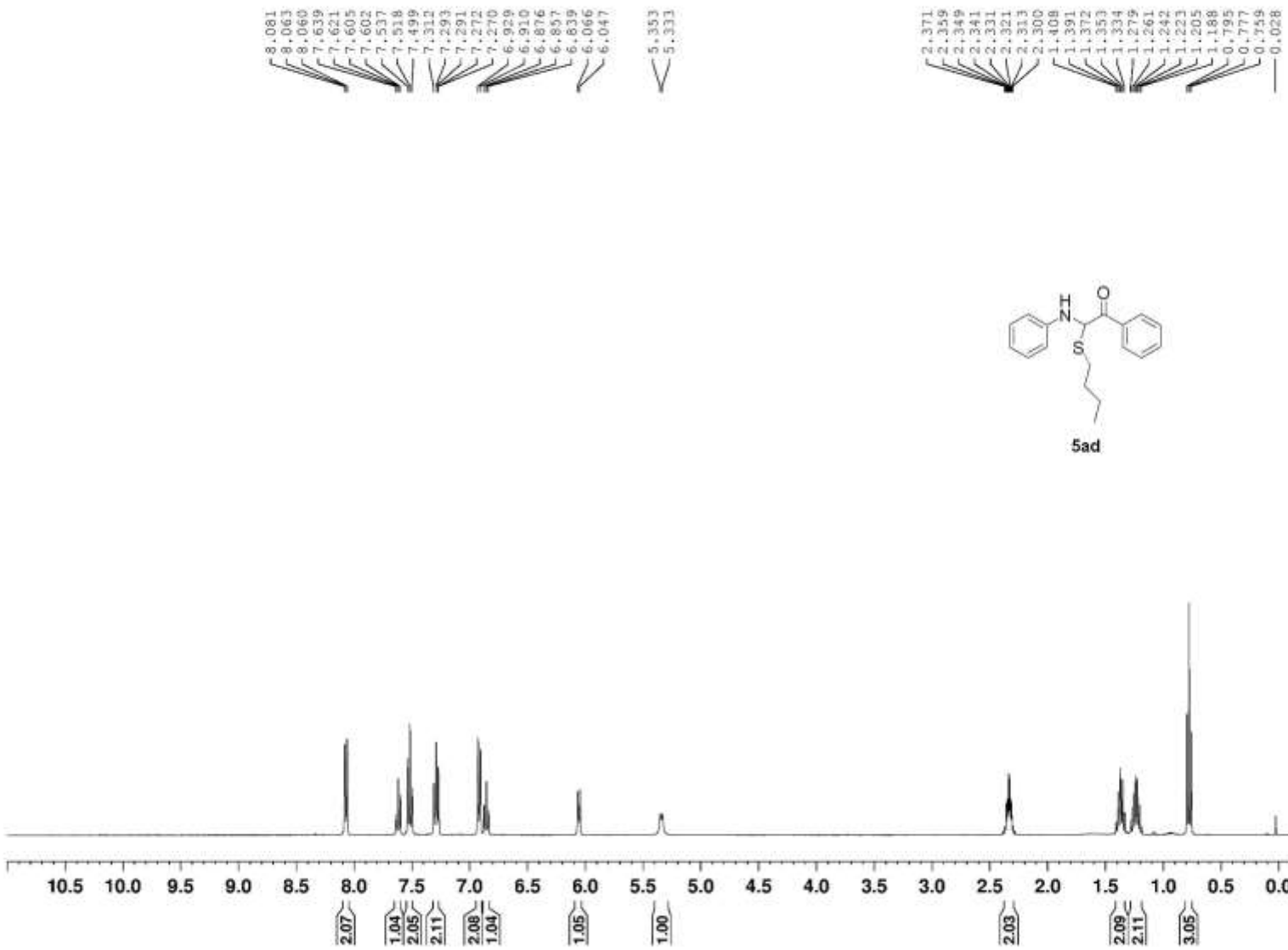

188.53
143.32
138.05
133.81
133.45
130.75
130.58
129.28
127.55
119.05
114.35
77.32
77.00
76.68
59.99
33.16
25.01
24.30
Cl
Cl
5ya
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

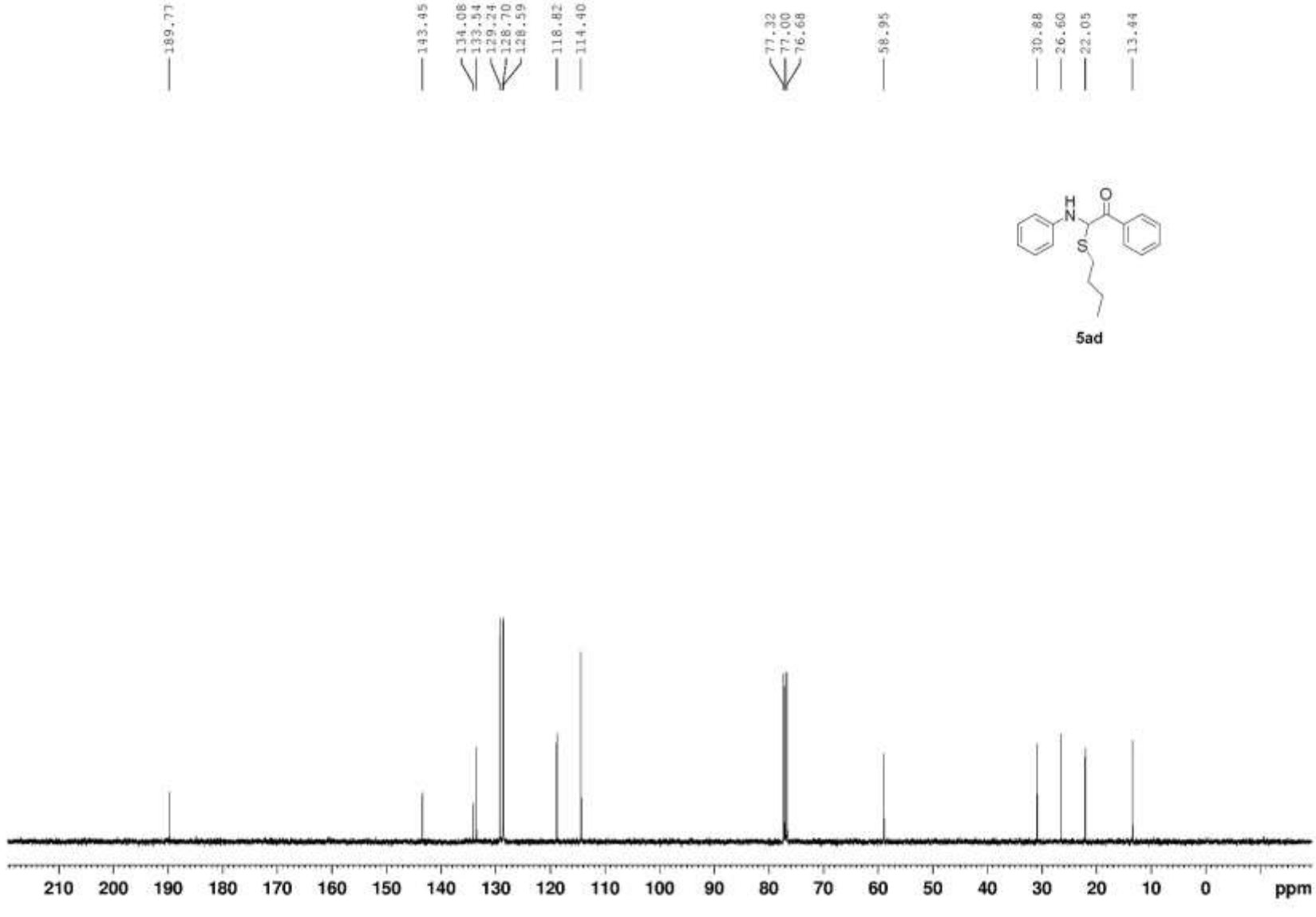

8.089
8.071
8.067
7.644
7.641
7.630
7.625
7.610
7.607
7.542
7.522
7.503
7.319
7.300
7.297
7.279
7.270
6.933
6.914
6.882
6.864
6.846
6.077
6.058
5.375
5.356
2.415
2.403
2.394
2.384
2.375
2.365
2.356
2.346
2.338
2.326
1.096
1.078
1.059
0.034
5ab
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.06
1.03
2.07
2.05
2.10
1.04
1.04
1.00
2.08
3.09

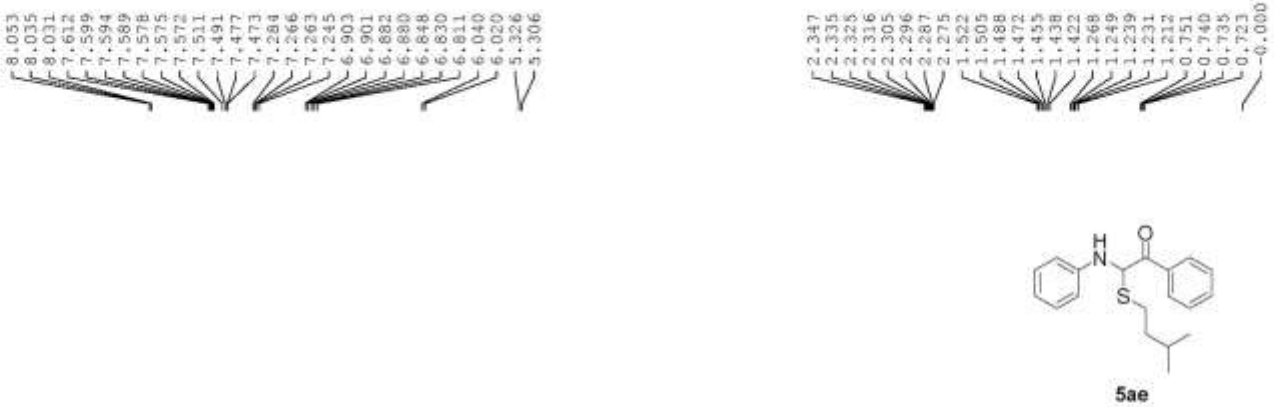

189.79
143.43
134.00
133.58
129.26
128.71
128.60
118.83
114.36
77.32
77.00
76.68
59.03
21.11
13.96
H
N
O
S
5ab
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

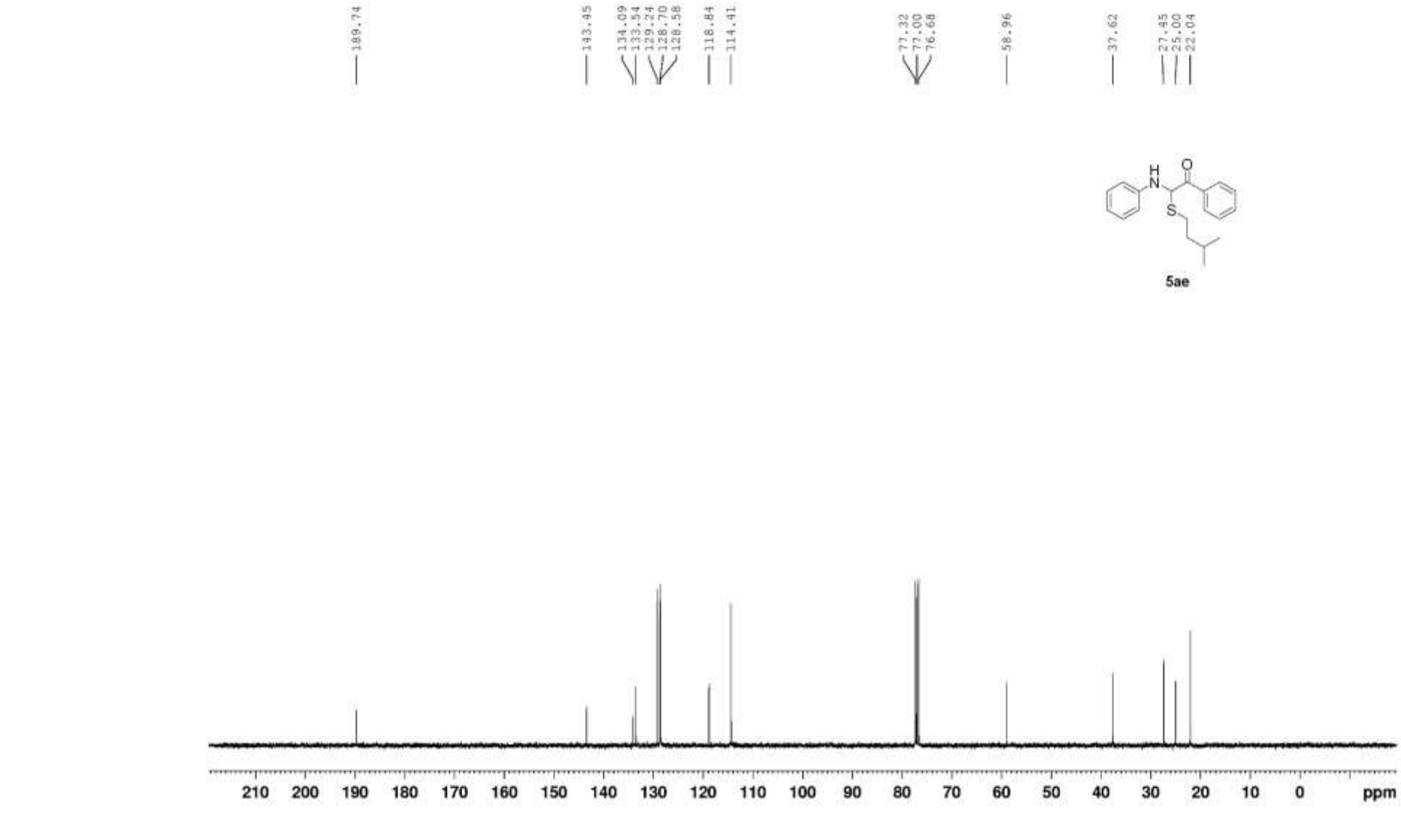

8.083
8.065
8.061
7.642
7.639
7.636
7.626
7.621
7.616
7.606
7.603
7.599
7.538
7.518
7.504
7.500
7.312
7.293
7.291
7.272
7.270
6.930
6.911
6.875
6.857
6.838
6.066
6.047
5.355
5.337
2.336
2.332
2.318
2.314
2.299
2.295
1.461
1.442
1.424
1.405
1.387
1.369
0.837
0.819
0.801
0.026
5ac
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.08
1.07
2.14
2.19
2.11
1.08
1.06
1.00
2.09
2.25
3.04


189.82
143.45
134.07
133.56
129.25
128.71
128.60
118.83
114.40
77.32
77.00
76.69
50.93
28.94
22.38
13.58
5ac
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

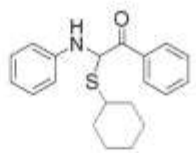

8.081
8.063
8.060
7.639
7.621
7.605
7.602
7.537
7.518
7.499
7.312
7.293
7.291
7.272
7.270
6.929
6.910
6.876
6.857
6.839
6.066
6.047
5.353
5.333
2.371
2.359
2.349
2.341
2.331
2.321
2.313
2.300
1.408
1.391
1.372
1.353
1.334
1.279
1.261
1.242
1.223
1.205
1.188
0.795
0.777
0.759
0.028
H
N
O
S
5ad
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.07
1.04
2.05
2.11
2.08
1.04
1.05
1.00
2.03
2.09
2.11
3.05


189.77
143.45
134.08
133.54
129.24
128.70
128.59
118.82
114.40
77.32
77.00
76.68
58.95
30.88
26.60
22.05
13.44
NH
O
S
5ad
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

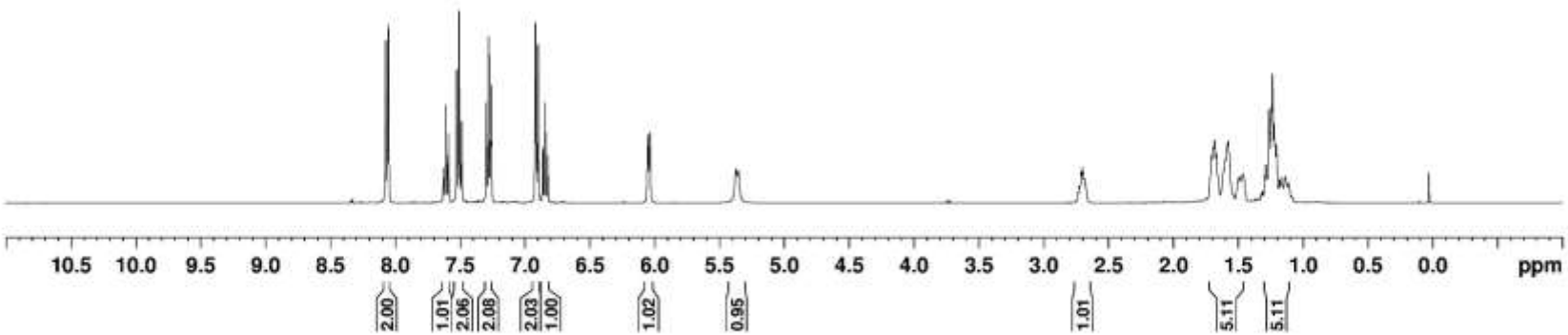

8.053
8.035
8.031
7.612
7.599
7.594
7.589
7.578
7.575
7.572
7.511
7.491
7.477
7.473
7.284
7.266
7.263
7.245
6.903
6.901
6.882
6.880
6.848
6.830
6.811
6.040
6.020
5.326
5.306
2.347
2.335
2.325
2.316
2.305
2.296
2.287
2.275
1.522
1.505
1.488
1.472
1.455
1.438
1.422
1.268
1.249
1.239
1.231
1.212
0.751
0.740
0.735
0.723
-0.000
H
N
O
S
5ae
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.07
1.03
2.05
2.10
2.09
1.04
1.04
1.00
2.08
1.08
2.11
6.03

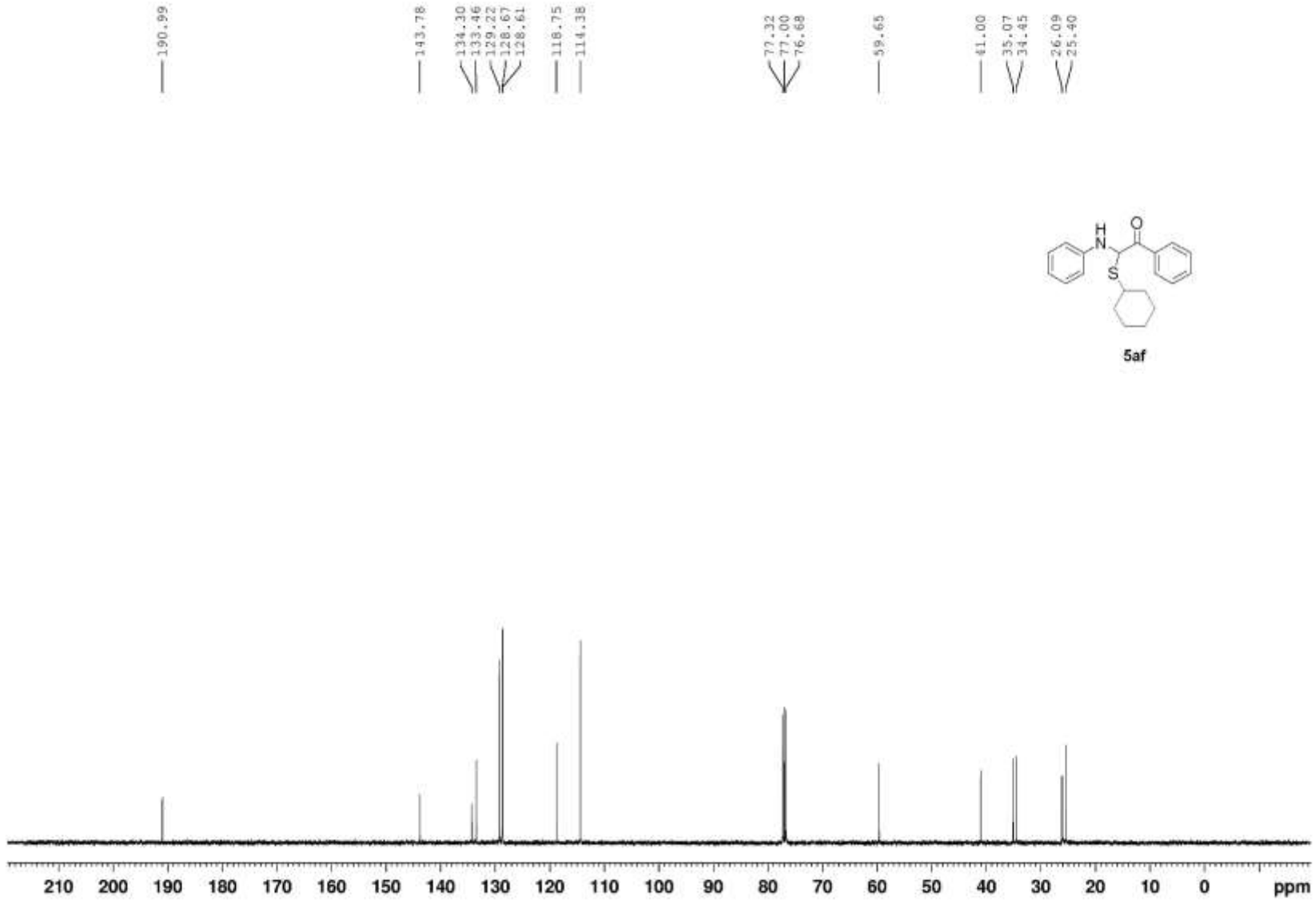

189.74
143.45
134.09
133.54
129.24
128.70
128.58
118.84
114.41
77.32
77.00
76.68
58.96
37.62
27.45
25.00
22.04
5ae
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


8.076
8.057
8.054
7.630
7.612
7.593
7.529
7.510
7.491
7.301
7.283
7.281
7.269
7.262
6.921
6.901
6.864
6.846
6.827
6.056
6.038
5.375
5.357
2.737
2.728
2.712
2.703
2.693
2.688
2.679
2.708
1.696
1.684
1.671
1.614
1.603
1.587
1.579
1.496
1.475
1.465
1.297
1.289
1.264
1.246
1.238
1.224
1.216
1.208
1.201
1.189
1.181
1.173
1.164
1.142
1.114
0.030


H
N
O
S

5af


10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
1.01
2.06
2.08
2.03
1.00
1.02
0.95
1.01
5.11
5.11


190.99
143.78
134.30
133.46
129.22
128.67
128.61
118.75
114.38
77.32
77.00
76.68
59.65
41.00
35.07
34.45
26.09
25.40
H
N
O
S
5af
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm